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Physiography and Herpetology in the Lesser Antilles

By E. R. Dunn[1]

W. M. DAVIS' book "The Lesser Antilles" was published by the American Geographic Society in 1926. It contains no reference to Herpetology, and I can find no reference to it in any more recent paper on the Herpetology of the islands. Problems met with in going through the collections of the Philadelphia Academy have led me to compare the conclusions of this distinguished geographer with our knowledge of the amphibians and reptiles. All quotations in this paper are taken from Davis.

It has long been known that the Lesser Antilles consist of an inner arc of islands composed of volcanic rocks, and an outer arc of limestone islands. Some of the latter show cores of older volcanic rock. Davis has shown that the volcanic islands are not all of the same age. There are single young cones; composite islands made up of cones of varying ages; and old islands, reduced by submergence, subaerial erosion, and marine abrasion. It is important to note that these categories are not "systematically arranged along the island chain," i.e., close neighbors may be of quite different ages, as witness Redonda, an old, much reduced "remnant" lying between the much younger islands of Nevis and Montserrat.

Nor are the limestone islands of the same age. Some are simply slightly uplifted atolls; some have undergone tilting as well as uplifting; some may have been almost-atolls, in which the original volcanoes were never completely submerged, and were only partially covered with limestone. Barbados has a substratum of "strongly deformed and much eroded strata, mostly mudstones and sandstones, apparently an unheaved part of a continental shelf," and it has been completely submerged because the older rocks are covered by a "cloak of calcareous rocks containing pelagic fossils." These categories, also, are not systematically arranged along the island chain.

The only orderly arrangement found is that the volcanic islands form a chain, and that to the east of them is another chain of islands which have undergone considerable subsidence, deposition of limy materials, and subsequent re-elevation. Davis calls the first set "first cycle" islands, and the second set "second cycle."

The individual islands are so diverse in their histories that a comparison of the herpetological faunas should be very interesting and illuminating. I have naturally selected for this purpose some of the more extreme types of Davis' classification. I have also thought it best to consider all the islands in one complete cross section of the double chain. For this section I have chosen the northern portion, beginning at the north with Sombrero and ending at the south with Montserrat. This section is as physiographically diverse as any. Dog island, south of Sombrero, is not mentioned by Davis, and is unknown herpetologically. It is therefore omitted.

A preliminary outline of possible situations may elucidate the conclusions to be drawn from the factual comparisons.

[1] **Contribution from the Biological Laboratory, Haverford College, No. 23.**

I. In any island group, if the islands have similar histories and uniform faunas, no comparison of island with island, nor of island fauna with island fauna, will serve to inform us whether the fauna is "waif" or "survival." The question will have to be decided on other grounds.

Insular endemism will presumably take place in a survival fauna if the isolation of the islands from each other lasts long enough. It should also take place in a waif fauna if exchange of waifs is quite infrequent. It will presumably not take place if the period of isolation is brief, or if exchange of waifs is very frequent. I cannot, therefore, see the point of Mertens' ideas (Zoologica, 32, 6, 1934: 84) wherein only those islands which show a uniform fauna, with no specific endemism, are regarded as oceanic and populated by waifs. Nor can I approve the surprising disregard for geographic and geologic data in a work which is so admirable zoölogically.

II. If the islands of an island group have similar histories but show quite different faunas the situation would be a puzzle indeed, but I know of no such case.

III. If the islands of an island group have very diverse histories (as the Lesser Antilles) and a relatively uniform fauna, the fauna is presumably waif. A fauna which is uniform on islands some of which are recently emerged volcanoes, some uplifted atolls, some uplifted almost-atolls, some uplifted submarine banks, and some (possibly) the remnants of peaks of a continental area, cannot be a survival fauna.

IV. If the islands of an island group have very diverse histories and very diverse faunas, a comparison should show this diversity. For an answer to the question of waif versus survival it would be necessary to inquire beyond the limits of the group.

Davis has shown that the Lesser Antilles are very decidedly a group composed of islands of diverse ages and histories. The first and second possibilities are therefore debarred from further consideration.

It is obvious that newly emerged volcanoes can be populated only by plants and animals which have arrived by some other means than overland; i.e., waifs. The same is true for islands which have been completely submerged.

"Second cycle islands which passed through the final or atoll stage of the first cycle must . . . be populated only by waifs, except in so far as certain first cycle occupants survived on reef-sand islets."

Survivors of an early land bridge fauna might be found on old volcanic islands or on islands which have been almost-atolls.

A quantitative comparison between islands in relation to area and elevation should be made since larger islands should have a larger fauna (waif or survival) than smaller ones. It is important to note that the really old Lesser Antillean islands are all small (Redonda, the Saintes, the Grenadines).

For most of our knowledge of the herpetological fauna of the Lesser Antilles we are indebted to Dr. Thomas Barbour. As most of his publications about this area appeared before the work of Davis it is not surprising

that his zoögeographic conclusions are somewhat different from those which will appear later.

Three factors make any consideration of an insular fauna imperfect.

1. Unequal investigation of the islands,
2. Unequal extinction on different islands.
3. Differences of introduction on different islands.

Some of these may cancel each other in any quantitative count. Qualitatively, the differences are unimportant. I append a list of the species reported from each island in the selected section.

In the Lesser Antilles two or more islands may rise from a single submarine bank. These banks have a maximum depth of 40 fathoms at the edge. All islands on the same bank seem to have the same physiographic history. The fauna of islands on the same bank is nearly identical. This may be because of their similar histories and their propinquity, or because they have very recently had land connections with each other. Davis considers that a lowering of sea level by 30 fathoms occurred in glacial times, that such a lowering would have cut down the banks by wave action to a maximum depth of 70 fathoms, and that the present depth of 40 fathoms is due to postglacial aggradation. But the depth between the islands is not the maximum bank depth, and the glacial lowering of the ocean may well have laid bare land connections between islands within the last 35,000 years.

Two zoögeographic considerations emerge from the foregoing idea. The first is that instances of specific endemism differentiating islands on the same bank might be re-examined. The second is that in comparisons of the fauna, that of banks, rather than that of specific islands, might be considered.

Saba is "certainly" one of the volcanic islands "built up after their part of the assumed land bridge had been submerged"; Redonda is "a solitary remnant." Both are volcanic. Their faunas should be different, but Saba has five species, one endemic, while Redonda has three, two of which are endemic. Barbados "has been completely submerged since its first insular existence." Barbados has ten species, two endemic. The species of the three islands are all of widespread Antillean genera save that Barbados has a mainland *Phyllodactylus* and a mainland *Centropyx*.

No newer cone than Saba exists, no more surely submerged island than Barbados, and no older volcanic island than Redonda. There is no apparent correlation between fauna and history, as the fauna is essentially the same.

Sombrero is "an uplifted and cliffed atoll" while "Barbuda.......... exemplifies an advanced stage in the production of a bank........by the aggradation of the down-tilted part of the first cycle atoll, just as Antigua exemplifies the development of an island of the second generation by the degradation of the uplifted part." Barbuda and Antigua are on the same bank. All three islands should have a fauna which can survive on an atoll, unless waifs have come in. Sombrero has one species, an endemic *Ameiva*. Barbuda and Antigua, which have passed through a Sombrero-like stage, should not have much more. Antigua has 11 species, two

endemic; Barbuda four, two endemic. The Antigua-Barbuda bank has 11 species, six of which are known only from the islands on the bank. If Barbuda is, as Davis implies, built up by aggradation, its fauna must be waif, not survival, unless it came from Antigua by an overland route during the glacial period. The fauna of Barbuda and Antigua differ, as each has two endemic anoles, two pairs of vicarious forms.

Some less extreme islands remain: volcanics of moderate age, and limestone islands which may have been almost-atolls. In the first category are the islands on the St. Kitts bank (Statia, St. Kitts, and Nevis) and Montserrat, of which Davis says "it is probable" that these "may have been built up after their part of the assumed land bridge had been submerged. Here the fauna must consist of waifs only." In the second category are the islands on the Anguilla bank (Anguilla, St. Martin, St. Barts) on which the observations "do not suffice to determine whether the upper limestones originally extended over the highest part of the volcanic rocks," which may, in short, have been either atolls or almost-atolls. Davis, however, says that these three islands "provisionally......represent a former atoll which has been gently tilted......the uplifted......part has been much reduced by erosion." The two sets should have either similar waif faunas or rather different survival faunas.

Actually Statia has seven species, one endemic; St. Kitts has 11, two endemic; and Nevis has eight. Twelve types are found on the bank; five forms are not known elsewhere. There are apparently three cases in which forms on one island are vicarious representatives of those on another; *i.e.*, there seems to be some local differentiation.

Montserrat has nine species, three endemic.

On the Anguilla bank, Anguilla has five species, one endemic; St. Martin has eight; St. Barts five. Eight types are known from the bank, four of them not known elsewhere. The *Ameiva* of Anguilla seems to be different from the *Ameiva* common to St. Martin and St. Barts.

Qualitatively, there is little to say. Any contrast between what is present on a volcanic island and what is lacking on a second cycle island could be reproduced by a similar contrast between members of the same set. The chain of volcanic islands as contrasted with the chain of second cycle islands (in the area chosen) show the following dissimilarities:

Bufo marinus: not present in any second cycle island; known from three first cycle islands; almost certainly very recent introduction.

Leptotyphlops albifrons: not present in any volcanic island; known from the second cycle island of Antigua.

Constrictor constrictor orophias: not known from any limestone island; a very dubious record from the volcanic island of St. Kitts.

These dissimilarities do not seem to me in any way significant.

To consider number of species in relation to area:

Sombrero, one mile long and 40 feet high, has one species.
Redonda, one mile in diameter and 1000 feet high, has three species.
Saba, 2½ miles in diameter, 2820 feet high, has five species.
Montserrat, 8 by 5 miles, 3002 feet high, has nine species.

These four isolated islands, irrespective of their diverse histories, have species in direct ratio to their size and elevation. The islands on banks

show much the same phenomenon.

Statia, 2 x 4 miles, 1950 feet, seven species.
St. Kitts, 12 x 5, 4314, eleven species.
Nevis, 5 x 7, 3596, eight species.
St. Barts, 2 x 5, 992, five species.
St. Martin, 4 x 7, 1360, eight species.
Anguilla, 12 x 3, 213, five species.
Barbuda, 7 x 12, 112, four species.
Antigua, 13 x 16, 1330, eleven species.

Qualitatively, the herpetological fauna of the Lesser Antilles shows no genera which are not present in South America; few which are not also present in the Greater Antilles. There is considerable insular endemism in species, of which *Iguana delicatissima* is perhaps the most marked example. There is no qualitative difference between islands of the most diverse histories.

Quantitatively, these small islands harbor fewer genera and species than either the Greater Antilles or South America. Islands of approximately the same size but of very diverse histories do not differ quantitatively, but islands of different sizes have species in direct ratio to size and elevation.

In reaching Saba and Barbados the components of this fauna have behaved, and hence can behave, as waifs. This makes it difficult or impossible to assert that any of it is survival, although it is equally impossible to deny that, on the older islands, some of it may be survival from a land bridge or continental fauna.

The herpetological fauna of the Lesser Antilles cannot, therefore, be used as a proof of continuous land connection in past times with either South America or with the Greater Antilles.

It may be well to review the facts concerning some other groups.

The large land mammal *Amblyrhiza* is known as fossil from Anguilla and St. Martin, two islands on the same bank near the northern end of the chain. These islands have been atolls or almost-atolls. Davis takes the view that "this heavy land animal could have reached the......group only by a land bridge at the opening of its first cycle history" (which may, for the moment, be accepted) and that "it appears also to exemplify the view that the extinction of a land mammal would occur when the late stage of the first cycle......was reached" (which may be unequivocably accepted). The other land mammals of the group are classed as of recent introduction. Some of the bats "are quite distinct from the mainland forms, usually as well marked genera." These may be survivals of a land bridge fauna, shifting, by flight, from island to island as the land sank.

"The avifauna of the Grenadines presents some striking peculiarities." The Grenadines (and the Saintes and Redonda) are the oldest land surfaces of the Lesser Antilles. Possibly the birds of the Grenadines are survivals from a sunken land bridge.

Nothing in the Herpetology of these islands presents us with anything comparable to the bird or the bat situation.

The following forms are known from or have been recorded from the islands in the selected section (Sombrero to Montserrat, inclusive). I

shall not give the original records, save in cases of forms apparently not now in museums from the islands concerned, or where a record has not appeared in recent lists.

Bufo marinus: The Museum of Comparative Zoology has specimens from St. Kitts, Nevis, and Montserrat.

Leptodactylus fallax: St. Kitts, M.C.Z.; Antigua (Günther, Cat. Batr. Sal. Brit. Mus., 1858: 28, as *Cystignathus fuscus,* "Adult: stuffed," no collector named, apparently no longer extant).

Eleutherodactylus martinicensis: St. Martin (Cope, Proc. Amer. Phil. Soc. 11, 1870: 159); Saba, M.C.Z.; St. Eustatius, B.M.N.H.; St. Kitts, B.M.N.H., M.C.Z.; Nevis, B.M.N.H., M.C.Z.; Antigua, B.M.N.H.; Montserrat, B.M.N.H., M.C.Z.

Hemidactylus mabouia: St. Martin, A.N.S. (new record); Antigua, U.S.N.M., B.M. N.H.; Montserrat, B.M.N.H.

Thecadactylus rapicaudus: Saba, M.C.Z.; Anguilla, M.C.Z.; St. Martin, A.N.S. (new record); St. Barts, M.C.Z.; Antigua, A.N.S., B.M.N.H.; Nevis, B.M.N.H.; Montserrat, B.M.N.H.

Sphaerodactylus sputator: Described from Statia, types in Stockholm.

Sphaerodactylus pictus: Described from St. Kitts, on the same bank as Statia, type in the M.C.Z.

Sphaerodactylus elegantulus: Described from Antigua, type in M.C.Z.; Barbuda (same bank), M.C.Z.

Iguana iguana iguana: Saba, M.C.Z.

Iguana iguana rhinolopha: St. Kitts (Gray, 1845, Cat. Liz., Brit. Mus.; 186, specimen no longer extant).

Iguana delicatissima: Anguilla, M.C.Z.; St. Martin A.N.S.; St. Barts, M.C.Z.; Statia, M.C.Z.; Nevis, M.C.Z. If an iguana occurs on St. Kitts, between Statia and Nevis, one would think it would be of this species.

Anolis sabanus: Described from Saba, type in M.C.Z.

Anolis wattsi: Described from Antigua, type in B.M.N.H.; Statia, M.C.Z.; St. Kitts, M.C.Z.; Nevis, B.M.N.H.

Anolis forresti: Described from Barbuda, type in M.C.Z. This distribution of allied rock anoles is odd, with *wattsi* on the three volcanic islands of the Statia bank and the limestone island of Antigua, while Barbuda, on the same bank as Antigua, has *forresti.*

Anolis lividus: Described from Montserrat, type in M.C.Z.

Anolis gingivinus: Described from Anguilla, type in B.M.N.H.; St. Martin, A.N.S.; St. Barts, M.C.Z.

Anolis bimaculatus: Described from Statia, type in Stockholm; St. Kitts, A.N.S., M.C.Z.; Nevis, M.C.Z., B.M.N.H.

Anolis barbudensis: Described form Barbuda, type in M.C.Z.

Anolis antiquae: Described from Antigua, type in M.C.Z.

Ameiva corvina: Described from Sombrero, types in M.C.Z. and A.N.S.

Ameiva garmani: Described from Anguilla, type in M.C.Z.

Ameiva pleii: Described from Martinique, apparently erroneously. St. Martin, M.C.Z., A.N.S.; St. Barts, M.C.Z., A.N.S. These two islands are on the same bank as Anguilla. A specimen in the A.N.S. is labeled St. Eustatius, but this may be an error as Statia has the following form certainly.

Ameiva erythrops: Described from Statia, types in A.N.S.; Nevis, M.C.Z.

Ameiva erythrocephala: Described from St. Kitts, type in Paris, M.C.Z. This is another queer case as St. Kitts is between Statia and Nevis and on the same bank.

Ameiva griswoldi: Described from Antigua, type in M.C.Z.; Barbuda, M.C.Z.

Ameiva atrata: Described from Redonda, type in M.C.Z.

Ameiva pluvianota: Described from Montserrat, type in M.C.Z.

Mabuya sp.: St. Martin (Cope, 1869, Proc. Amer. Phil. Soc. 11: 159) A.N.S.; Redonda, A.N.S. (new record); Montserrat, U.S.N.M. (new record). The specific status of these scincs is a problem which I hope to elucidate soon.

Typhlops cf. jamaicensis: St. Kitts, M.C.Z.; Antigua, B.M.N.H.; Montserrat, B.M. N.H.

Leptotyphlops albifrons: Antigua, B.M.N.H.

Constrictor constrictor orophias: St. Kitts (Barbour, Mem. Mus. Comp. Zool., 44, 2, 1914: 330, "The Philadelphia Zoological Garden has had one said to have been taken upon St. Kitts"). Barbour considers the record very dubious.

Alsophis rijgersmaei: Described from St. Martin, types in A.N.S.; Anguilla, M.C.Z.; St. Barts, M.C.Z. The later named *cinereus* Garman based on the M.C.Z. specimens from Anguilla and St. Barts, on the same bank as St. Martin, which is between them, cannot at present be considered different. I have examined the four extant types of *rijgersmaei* in the A.N.S. and Garman's description of *cinereus* fits them accurately. Thus no difference between the two is known to exist.

Alsophis rufiventris: Saba, M.C.Z.; Statia, B.M.N.H.; St. Kitts, M.C.Z.; Nevis, M.C.Z.

Alsophis leucomelas antiquae: Described from Antigua, type in B.M.N.H.

Alsophis leucomelas manselli: Described from Montserrat, type in B.M.N.H.

It may not be out of place to mention the surprising absence of the snake genus *Dromicus* from these islands. The genus is known from St. John and Tortola in the Virgins, and from Guadeloupe, but not from St. Croix or the islands listed above.

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Observations on Antillean Tortoises and Terrapins

By T. BARBOUR

IN COPEIA for July 30, 1934, there is an article by Grant and De Sola entitled, "Antillean Tortoises and Terrapins: Distribution, Status, and Habits of *Testudo* and *Pseudemys*." Since I can agree with few, if any, of the conclusions reached in the paper I think perhaps it may be worth while to put my ideas on record at the present time.

I think workers who have had any general experience with systematic zoology can almost instinctively tell whether or not a given species or group of species has a natural distribution. The West Indian fresh water tortoises certainly have. Their systematic status is still in confusion and the present paper does nothing to improve this situation, and until the types of the original names are found, especially those which were inadequately described from specimens without definite locality, there is not much use applying names to the forms, except in an admittedly tentative way.

Pond terrapins are common all over Cuba. I have an enormous series from all parts of the island and there are two, and not improbably three, species to be found there, as well as areas where apparently extensive hybridization has taken place. Pond tortoises, owing to unfavorable conditions such as few ponds or rivers large enough to be sufficiently sluggish to provide suitable homes and also because they are widely trapped and eaten, are rare in Jamaica, Hispaniola and Puerto Rico. Evidence is as yet inconclusive as to whether two species occur on each one of these islands and whether or not the species on the several islands are distinct. There is evidence to show that some at least differ considerably and when

exactly comparable material is available—if it ever is—it may be worth while naming, possibly, a pair of forms on each island. A good deal of this is surmise, quite frankly so.

Now, with regard to the occurrence of *Testudo* in the Antilles. Here Grant and De Sola feel sure that we have to do with an endemic or natural member of the native fauna. But there is a mighty lot of difference between the evidence presented by the distribution of *Testudo* as compared to *Pseudemys*. In spite of what these gentlemen say there is not yet evidence of any value whatsoever to show that *Testudo* ever occurred wild in Cuba or in Jamaica or in Guadeloupe or, indeed, on any of the West Indian Islands except one or two small islets in the Virgin group whence specimens appear from time to time in the past to have been brought to Puerto Rico and sold.

The whole literature of zoology is full of published records which are worthless because they are based on living specimens carried about or on specimens wrongly labelled in museums that have got to be sifted and used with the greatest care and, generally speaking, the old records are the worst and least reliable. Guadeloupe and Martinique are both bad traps for the unwary, for apparently material from a host of localities around the Caribbean basin, at one time or another, was assembled at one of these French islands before being shipped to Paris, where the material now bears a locality label indicating the point of shipment only.

Another fact which is worth pointing out is the contrast between the distribution of *Testudo* and *Cyclura* and the extraordinary correspondence of that of *Cyclura* with *Pseudemys* insofar as correspondence is environmentally possible, contrast also the distribution of *Iguana*.

I have just looked up Reinhardt and Lütken's paper read before the Copenhagen Natural History Society in 1862 and these two highly intelligent gentlemen questioned the record for Cuba and also that for the Virgin Islands. This is not the only occasion where the genus *Testudo* has caused trouble. Study the history of the *Testudo* records with regard to the Island of Halmahera for a beautiful parallel case.

The absence of *Testudo* bones from caves and shell heaps is very significant. This is not because testudos were not eaten. On the contrary they are extremely good and all intelligent people, primitive or otherwise, eat them whenever the opportunity presents itself.

While tortoises may have become feral on these little cays mentioned by Grant, I do not believe that is in the least significant. Goats are feral on Beata and donkeys, horses and bulls on Inagua and cats on Cat Island and dogs in the mountains of Cuba, and the mongoose and the giant toad (*Bufo marinus*) here, there and everywhere, so that when Grant and De Sola say that "The tortoise occurs alive and feral in Cuba, Jamaica, Lovango Cay and Water Island," they are, perhaps, correct insofar as the last two are concerned and, I believe, certainly incorrect regarding the first two. They must also go to the dictionary and look up the word "feral." It does not mean native but applies to an artificial introduction which has run wild, has *become* feral. The West Indian Islands have never been as well known as they are today and the Lesser Antilles

especially have been repeatedly visited by good collectors who have made long stays as well as by poor collectors like myself who have made short stays, albeit a good many dozens of them. Let me add that if others besides Mr. De Sola and Mr. Hasseler have the good fortune to find testudos in Cuba and Jamaica and Santo Domingo this fact will still leave me perfectly cold as to their being an integral part of the islands' native fauna. Where are the Central American testudos? What other genus of Greater Antillean reptiles is without Central American affinities? What other certainly Antillean reptiles are found, far and wide, common as can be, over all the area of the Guianas, and tropical Brazil and probably most of Venezuela, eastern Peru and a large part of Colombia and Trinidad? Here the species is known to all and sundry. It is regularly found by all naturalists. It is regularly brought from native markets to our Zoological Parks. This distribution is also characteristic of a host of other reptiles —none of which occurs in the Greater Antilles.

One last word I must repeat and that is how extremely pleasant a pastime eating tortoises really is.

Since I wrote these observations I have shown them to Dr. Stejneger. His first question was, where is there any authorization for stating that the "precolumbian Indians" did not eat *Testudo* when they did eat *Pseudemys*?

Where is the evidence of *Testudo* occurring in Hispaniola, Cuba or Jamaica in precolumbian times?

He then pointed out what Gosse in his "Naturalist's Sojourn in Jamaica" says on pages 421-425—I will not quote all that Gosse says but one sentence on page 422 epitomizes his ideas. "I must mention that Land Tortoises, brought from South America and elsewhere, frequently get away, and are in this manner found solitary. Some fifty of a prodigious size, brought by a Spaniard for sale, broke away near Kingston, and several, for months after, were found round about."

Then more important still, Dr. Stejneger has sent me the translation of a statement on page 291 of the article by Reinhardt and Lütken, in addition to the one to which I have already referred. They say: "According to Riise no land turtles occur on our West Indian islands (the Virgin Islands) although already West (Bidrag til Beskrivelse af St. Croix) mentions a land turtle as occurring, though rarely, on St. Croix, from which island we also have received a couple of *Testudo tabulata* Wahlb. sent us alive. Although he has seen rather small land turtles several times on St. Thomas, one in the garden of the hospital and one in the cemetery, he does not feel justified in supposing that they really occur on our islands either wild or escaped. They are brought for sale to the islands from the coast (Venezuela), and Riise has occasionally seen 20-30 for sale in the market. Riise has two pairs in his yard, but they hide constantly and appear only after a rain or when hungry; often several months pass between each time they are seen. They are eaten, and are fed fruit, melon rinds, pine apple peelings, etc." (Reinhardt and Lütken, Middel. Naturh. For. Kjobenhavn, 1862 (p. 291), author's separate, p. 139.)

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Infection with Amphibian Tubercle Bacilli Connected with a Case of 'Sex Reversal' in a Frog

By Lawrence E. Griffin

THE case of modified sexuality in a frog to be described in this contribution is added to the rather long list of such which is already known because the presence of amphibian tuberculosis bacilli was discovered in the modified gonad. Considered in connection with the discoveries by Crew and Riddle of birds which were changed sexually and were tubercular, the case seems to strengthen the possibility of an interesting connection between tuberculosis and the expression of secondary sex characters.

In January, 1924, we received from a biological supply house in Chicago a shipment of frogs, *Rana pipiens,* for dissection by students of the course in general biology. The frogs were killed and preserved in formalin at some time before being shipped. During dissection one of the frogs was found to have an organ resembling a testis on the right side and an ovary on the left side. The testis-like organ was removed and sectioned to determine if it really possessed the structure of a testis. The microscopic examination proved that it consisted almost entirely of testicular tissue of normal appearance. The only apparent abnormality was that a small bit of ovarian tissue, not quite as long or as thick as the testis, was attached to its posterior end.

The ovary on the left side of the frog appeared to be a normal organ in the stage of development commonly found in the late summer. The left oviduct was normal; the right one was smaller, yet larger than the Müllerian duct of a normal male frog. Seminal vesicles and vasa efferentia were as well developed on the right side as in ordinary male frogs of this species.

Sections showed testicular tissue of about normal type. The sperm tubules were crowded with developed spermatozoa and their walls contained recognizable spermatids and spermatocytes. The germinal epithelium appeared thinner than is usual and the tubules were separated by a little more interstitial tissue than in ordinary testes. The small remnant of the right ovary was attached to the posterior end of the testis and extended along a groove in one side of the testis as far as its middle. The ova were in various stages of degeneration. A definite connective tissue capsule enclosed the testes except posteriorly, where there was no definite demarcation between testis and ovary, though there was no intermingling of testicular and ovarian tissue.

In the connective tissue between the tubules, and just under the capsule of this testis, numerous masses of bacteria were found. These were usually in rounded, closely packed aggregations. The bacteria were rod-shaped, 1μ to 2μ long and $.3\mu$ to $.4\mu$ thick. They were gram negative and not acid-fast. Only a few bacteria have been found in the tissues outside the nodules. The morphological characters of these bacteria are those of

the amphibian type of tubercle bacillus. The acid-fast character of this species is not constant, and this character may have been affected by the conditions of preservation of the specimen. The bacteriological findings were checked by Professor H. J. Sears and Miss Katherine Kerr of the University of Oregon Medical School.

Crew has compiled the records of 40 cases of this kind of sex-abnormality in frogs and toads, which varied in degree from the slightly abnormal female with a small amount of testicular tissue appearing in the ovary, to a completely reversed animal with two testes, showing scant traces of ovarian tissue, which was able to function as a male and effect fertilization of eggs. The single, completely reversed female (*Rana temporaria*) was discovered by dissection after it had copulated with a female of the same species, and had inseminated its clutch of eggs. Seven hundred seventy-nine frogs developing from this union were examined, and all were found to be females, normal in every respect. This sex ratio is what would be expected if the chromosome constitution of the sperm was female instead of male. As Crew says, the masculinized female was a *somatic male,* which possessed the anatomical organization of a male, but the chromosome constitution of a female.

Crew has also recorded the case of a buff orpington hen which, up to the age of three years, had been a good layer and mother of many chicks. During the next year and a half her plumage, general appearance, and copulatory behavior gradually changed to those of a cock. After being mated with a normal hen two eggs fertilized by the pseudo-cock hatched. The chicks developed into a hen and a cock. Upon the death of the masculinized bird shortly after, it was found to be in an advanced condition of tuberculosis.

Other less complete and striking cases of sex reversal in fowls were reported by Crew, and he states that in every case the development of testicular tissue was preceded by ovarian atrophy or disease.

Riddle reports an instance of a female ring dove which produced eggs in early life and later developed the copulatory actions of a male. It died of tuberculosis, and autopsy revealed the normal testes, etc., of a male.

We do not feel justified in making the positive statement that amphibian tuberculosis was the causative factor in producing the partial sex reversal in the frog which we have examined. But such is strongly indicated; and this case together with those of Crew and Riddle at least suggest that in the air breathing vertebrates tuberculosis may be a cause of such modifications, which may be of more common occurrence and more widely distributed in that group than we have suspected. It is evident that a physiological factor is the cause of the anatomical changes. It is also evident that the structure of the germ cell, i.e. whether it is an egg or a spermatozoan, is a secondary sex character which can be modified by the developmental influences under which it exists; and that the only primary sex character we are able to distinguish at the present time is the chromosomal constitution of the male or female organism. While it seems paradoxical, these cases show that under some circumstances it may be perfectly correct to speak of *female spermatozoa.*

SUMMARY. In a specimen of *Rana pipiens* the right ovary was found to be almost completely transformed into a spermary with normal structure and connections. In this nodules of bacteria were found, which have been identified as amphibian tubercle bacilli. This appears to be the first instance in which tubercle bacilli have been found in the modified gonad of an intersexual animal.

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Life History of the Blackhead Minnow (*Pimephales promelas*)[1]

By HENRY C. MARKUS

THE Cyprinidae are one of the characteristic families of North American fishes and are of indirect economic importance since they constitute the major portion of the food for the game and commercial fishes. With the exception of brief notes on their breeding habits, growth, food and distribution, information on the natural history of our minnows is lacking. Since the minnows are playing an important role as forage fish in the rearing of pond fish, it is essential to know the complete life cycle of all species used in order to handle them intelligently. With this motive the author has attempted to solve the life cycle of some of our important forage fish, but to date only the data on the black-head minnow have been completed and are herewith presented. The observations were made in the ponds of the U. S. Bureau of Fisheries Station at Fairport, Iowa.

In 1929 Van Cleave and Markus pointed out facts regarding correlation in size and age of the blunt-nosed minnow and found that both sexes have a distinctly limited life span. In the present study the author has found specific conditions which indicate that generalizations regarding the minnow family are unsafe, for even fairly closely related species show distinctive differences in the life cycle.

REPRODUCTION

Secondary sexual characters.—Secondary sex characters were noted on the males approximately thirty days before the first eggs were deposited, thus making it easy to distinguish males from females. The appearance of pearl organs or tubercles on the head and the coloration constitute the most

[1] Published by permission of the Commissioner of Fisheries.

evident secondary sexual characters. The occurrence of another secondary sex character is noted by Wynne-Edwards (1932: 382): "Specimens were first obtained on June 19th, 1931, and the males at that time had the rugose skin between the back of the head and the dorsal fin fully developed. This is striking in appearance; it is due to a thickening of the epidermis overlying the scales." This pad became prominent soon after the males began caring for the nest and they seemed to use it advantageously in keeping the nest clean as will be shown later in this paper.

At the time the males were developing their secondary sexual characters the females that were approaching the earliest spawning period were well distended with eggs.

The secondary sex characters began to fade immediately after the close of the spawning period and by August 27th they were very faint and nearly obliterated.

Location of nest.—It seems evident that the male chooses the location of the nest for he is often seen wandering about for hours, around a suitable place, where eggs were found later. Black-heads usually lay their eggs on the under side of objects that lie horizontal to or at an angle with the surface of the water. In only one instance was a nest found on a stake that was at right angles with the surface of the water and in this instance no normally suitable site was available in the pond.

Nests may be found under rocks, timber, concrete, metal or tile if there is enough space underneath the object for activity of the male. Wynne Edwards (1932: 382) states: "On the underside of many of the lily-pads was a layer of eggs, and it was a matter of a few moments to discover the male black-headed minnows which guarded them." If all the above objects mentioned were present in the pool the nests would invariably be found on the inner side of the tile. The under surfaces of pieces of broken or whole tiles seem to offer admirable places for them to deposit eggs and make it easy to transport the nests for experimental study.

Spawning.—In the spring of 1931 the first eggs appeared May 16th and in 1932 on May 5th. In both instances the temperature of the water was 64° F at the time the eggs were first seen.

It was noted that several batches of eggs first laid in the spring dropped off the day after they had been deposited. Upon examination, these eggs were found to be undeveloped. It was also noted, for single pairs which were kept in a pool, that the last group of eggs deposited by the female was undeveloped and dropped off the day after they were laid.

The eggs averaged 1.15 mm in diameter. The number of eggs per nest was found to vary from 36 to 12,000. It was found that more than one female deposits eggs on the same nest cared for by a single male. The size of the nest depends upon the number of females that have access to it and are ready for spawning. Never more than one male was found caring for a nest and if another male would come into the immediate vicinity of a male already ocupied an attack or a fight invariably resulted. In every observation, the incumbent male won out regardless of size.

Eggs are deposited in a single layer on the surface to which they are attached, but often they may be found two layers deep over part of the nest. In large nests eggs may be found in all stages of development due to the intervals of time that the various females deposited eggs. In pools where only one male and female black-head were present, eggs were often found in two stages. One average size female deposited eggs on the same nest twelve different times on the following dates: May 16th; June 3rd, 17th, 19th, 23rd and 28th; July 4th, 7th, 11th, 14th, 17th and 23rd. The eggs deposited July 23rd failed to develop. From this pair 4,144 offspring were recovered.

TABLE 1. AVERAGE WEEKLY MORNING AND AFTERNOON WATER TEMPERATURES OVER THE YEAR WHEN THE GREATER PART OF THE OBSERVATIONS WERE MADE.

The morning temperatures were taken at 8:00 A.M. and the afternoon temperatures at 5:00 P.M. The temperature readings are given in Fahrenheit.

Month	Days	Average Weekly Temperature		Month	Days	Average Weekly Temperature	
		A. M.	P. M.			A. M.	P. M.
May, 1931	10–16	62	72	December	5–11	36	37
	17–23	61	64		12–18	37	38
	24–30	69	77		19–25	40	41
June	31–6	68	75	January	26–1	38	39
	7–13	70	76		2–8	36	36
	14–20	76	85		9–15	37	38
	21–27	82	91		16–21	36	39
July	28–4	83	90		22–28	35	36
	5–11	74	80	February	29–4	35	37
	12–18	80	89		5–11	36	37
	19–25	80	87		12–18	37	38
August	26–1	78	86		19–25	39	43
	2–8	79	87	March	26–3	40	42
	9–15	73	77		4–10	35	36
	16–22	74	80		11–17	37	39
	23–29	71	77		18–24	36	35
September	30–5	70	77		25–31	45	52
	6–12	77	78	April	1–7	48	53
	13–19	74	79		8–14	48	53
	20–26	68	71		15–21	51	55
November	14–20	53	54		22–28	51	54
	21–27	46	47	May, 1932	29–5	60	64
December	28–4	38	39		6–12	64	67

Incubation period.—The length of the incubation period of the eggs was approximately five days. Eggs were always deposited during the night at the time the observations were in progress so the time was not obtained in hours. For example, eggs that were deposited some time during the night of July 4th would be eyed on the morning of July 7th and hatch on the 9th. The temperature of the water during the spawning period is given in Table 1. These observations were made in pools where there were only single pairs. Often eggs in two different stages of development were found on the same nest of a single pair of breeders, but as soon as new eggs were noted a circle was drawn around them and dated on the tile. Lord (1927: 93), who made observations on black-head minnows in 1926 at Fairport, Iowa, stated: "The time from the first appearance of eggs to

eyeing averaged 4 days. The time from the first appearance to the beginning of hatching averaged 6 days. The average time from appearance of eggs to entire hatching averaged 9 days." The difference in observation is due to the fact that eggs were deposited on the same nest at different intervals of time, which habit Lord also notes in his paper.

The length of newly hatched fry is 4.75 mm and they are milk-white in color. When seen swimming in the aquarium the eyes are the most conspicuous part.

Functions of the male.—The male performs three important functions when caring for the eggs during the incubation period. One is protection, which is often cited in literature. Second, his constant movement underneath the eggs which keeps the water continually agitated. This is more important than protection, for without agitation of the water the eggs will stop developing. This was soon discovered by the author attempting to move the eggs to aquaria for observation. If newly laid eggs, up to and including eggs that were beginning to eye, were taken from the male they turned white and fungused within twenty-four hours. It was found that if the eggs were transferred to an aquarium and water kept constantly agitated around the eggs, they would develop as if the male were present. As a field check of the foregoing laboratory observation, tiles in the ponds on which newly laid eggs were found were screened immediately and not removed from the spot where the eggs were originally deposited. The screen was put around the tile to keep the male from caring for the eggs. The eggs on such screened tiles as in the case of newly laid eggs transferred to quiet water in aquaria, turned white in twenty-four hours and became fungused. Other tiles screened in the same pond to exclude the male and put under the intake of the pond hatched as usual. The water coming from the inlet of the pond kept the water agitated around the eggs. So it seems evident that the function of the male in agitating the water over the eggs is far more important than merely protecting them.

The third function is keeping the nest free from sediment that may be deposited from the water. It seems that this may be necessary since blackheads are very much at home in turbid water. Numerous nests of eggs were hatched in aquaria by attaching a small rubber hose to a faucet and having the open end of the hose just beneath the eggs. This kept the water moving over the eggs and they hatched successfully. The water supply was from the Mississippi River. While the experiments were in progress the Mississippi became heavily saturated with sediment due to heavy rains. The sediment coming through the hose lodged on the eggs and they failed to hatch as long as the roily river water was used. This I think partly accounts for the male brushing the eggs with his back and the end of his head. Wynne-Edwards (1932: 383) states regarding the male stroking the layer of eggs: "The action of the male fish almost certainly results in turning them over and over, perhaps to permit a free access of oxygen to all sides, which may well be necessary for eggs spawned in stagnant muddy water." I can hardly understand how the male could turn the layer of eggs next to the object to which they are attached when the eggs are

two layers thick. It is a common occurrence to find one layer of eggs over the other. This is especially true of large nests and the inner layer of eggs hatches as well as the outer layer in all observations that I have made.

I am of the opinion that the agitation of the water over the eggs and keeping the nest free from sediment are not concerned with assuring adequate oxygen supply solely, for some of the aquaria in which newly laid eggs turned white had an oxygen content of twenty-five parts per million. The elimination of wastes and all physiological factors involved in life are taken care of by agitating the water over the eggs and keeping the nest clean.

Growth and Maturity

Development.—Eyed eggs from the early spring spawners, referred to as generation 1, were transferred to pond F2 on May 27th. This pond had been drained, dried and refilled to make certain that no fish were present except those put into it. The eggs had all hatched May 28th, the day after they were put into the pond. June 18th, 55 of these black-heads, or generation 2 were taken from pond F2 and placed into pool C1 where the conditions were less crowded. The minnows had attained an average length of 35 mm at this date. The following July 12th, faint secondary sex characters appeared on the males in both pond F2 and pool C1. By July 18th the characters were prominent and the females were well distended with eggs. On July 25th, eggs were found in both F2 and C1. Although eggs were found in both F2 and C1 on the same date, the black-heads averaged 5 mm longer in C1 than F2, but this apparently did not have any effect on the development of sexual maturity.

The black-heads that began spawning in the early spring as soon as the temperature permitted (generation 1) ceased spawning the middle of July. The last date that eggs were found from generation 1 was July 23rd. After this date they soon began to die. Generation 2 developed sexual maturity at the time when their parents (generation 1) ceased spawning and these fish continued spawning until August 17th. This was the last date that newly laid eggs were found from any of the black-head minnows regardless of age.

Many of the young hatched by generation 2 (constituting generation 3), attained a length of 55 mm before winter. They were sexually mature the following early spring spawning period. This growth was attained from July 29th to November 14th. The growth rate seems to be much slower in the late summer and autumn months than in the spring and early summer months. The minnows hatched in the early spring (generation 2) attained a length of 55 mm in two months whereas it took the late fry (generation 3) approximately three and one-half months to reach this length. There seems to be a greater variation in the growth rate among the individuals of the same age in the late summer and autumn growing months. The fish from a nest of eyed eggs transferred to pool C2 in which there were no other fish on July 29th were measured the following November 14th and the length was found to vary from 20 to 55 mm. This variation in size was not so pronounced among the fry that developed in the spring and early summer months.

The smaller minnows that were from 20 to 35 mm in length when the winter set in did not spawn the following early spring, but began later in the season. These helped to supplement the spawning activity during the latter part of the summer, that is, they were spawning at the same time that the young of generation 2 were spawning, which were the offspring from the early spawners of generation 1. Not all the minnows spawning at one time are of the same age, but may represent two distinct generations, since the spawning period of an individual female is approximately two months during the spawning season.

Males and females in the act of spawning may often be of the same size, but as a rule the male is larger than the female. The largest males found measured 78 mm in length while the largest female encountered measured 65 mm. Although the male was somewhat larger there was little variation in the size of the males and females that spawned during their first season, but the males that carried over into the second year became much larger than the females. This conforms to the observations on *Hyborhychus notatus* recorded by Van Cleave and Markus (1929: 534), "Even when we compare males and females of the same age, the disparity in size persists, for the males nearing the close of the second year exceeded the length of the oldest females by 1 cm."

The measurements referred to in this paper are from the tip of the nose to the base of the tail.

The author had three living generations of black-head minnows at one time, the oldest generation being just one year old. Generation 1, referred to previously, hatched August 3rd, matured during the late summer and autumn months, spawned the following spring on May 27th producing generation 2. Generation 2 in turn spawned July 25th and produced generation 3 on July 30th.

Growth during winter months.—Three size groups of minnows were kept under observation to determine if any growth is made during the winter months. In the past years it was the period from approximately November 14th to March 17th when the coldest weather was encountered at Fairport, Iowa, and the same was true at the time this experiment was in progress as shown by Table 1. The minnows were weighed and measured November 14th and placed into pools in which there was a normal supply of food. Minnows of the largest and smallest groups were kept in the same pool. These minnows were weighed and measured March 17th to determine if any growth had been made during the four winter months. It was found that the 135 black-heads that averaged 25 mm in length gained an average of 0.0451 gram per minnow. The 139 black-heads that averaged 50 mm in length had lost an average of 0.0275 gram per minnow, while those that averaged 70 mm in length had lost an average of 0.3590 gram per fish. Measurements taken March 17th failed to show any appreciable growth in length since November 14th.

The above observations indicate that the younger black-heads are more active and consume more food than the older and more mature fish in the winter months. This conforms to the conclusion of Markus (1932: 206):

"The small bass took food in much colder water than did the large bass as shown in tank C1 to 6 inclusive in Table 8."

Death rate.—The death rate of the adult minnows is very high after the spring spawning period. Through the latter part of July, August, September and October 85 per cent of generation 1 died after the spring spawning period. Generation 2 that spawned after July 23rd and again the following spring had a mortality of 80 per cent during the months of August, September and October. It may be that these fish did not take any active part in one or both of the previous spawning periods and that this enables them to carry over. It was noted that all individual pairs kept in separate pools died immediately after spring and early summer spawning period. It is this 15 or 20 per cent that constitute the large size individuals referred to earlier in this paper. The author was unable to determine the reason for the carrying over of this group into the third spawning season, since these studies were temporarily discontinued when he was transferred to Rochester, New York, from Fairport, Iowa, where this work was carried on.

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The Gills of *Amia calva* Specialized for Respiration in an Oxygen Deficient Habitat[1]

By Gerrit Bevelander

ACCESSORY respiratory organs in fishes are rather seldom and usually secondarily related to living out of the water. In the rock skipping blennies, *Andamia* and *Erpichthys,* and probably in the mud skipping gobies, Periophthalmidae, a primary specialization seems to have occurred in response to a change of environment (Hora, 1933). In all freshwater fishes with accessory respiratory structures however, the evolution of these structures has been correlated with an existence in oxygen-deficient water. This has been made especially clear in several recent studies of the fishes which live in these habitats. Perhaps the most satisfactory study of this subject is that of Carter and Beadle (1931), who found that the fishes of the great Chaco swamps of Paraguay show structural modifications which enable them to breathe atmospheric oxygen when the dissolved oxygen becomes depleted. Pearse (1932) made a study of the fauna of the tidal ditches of Siam and his findings closely parallel those of Carter and Beadle. Less organized contributions show that the same kind of modifications characterize the marsh inhabiting fishes of Africa. In fact this phenomenon has been found to occur so frequently, that it may be stated as a law: fishes inhabiting fresh waters which tend to lose their dissolved oxygen possess special means for obtaining oxygen either from (1) the trace remaining in the water, (2) the aerated surface film or (3) the atmosphere.

It has long been recognized (Wilder, 1878, etc.) that *Amia* breathes atmospheric oxygen into its air bladder. It has apparently not been pointed out that its gill filaments are highly modified, probably enabling the fish to use also the first method listed above for obtaining oxygen. *Amia* can presumably absorb dissolved oxygen when in very low oxygen-tension, because the gills are modified into what appears to be a most unusually effective respiratory mechanism. In *Amia,* each hemibranch consists of a row of longitudinally appressed filaments, and in a section of the hemibranch which is cut longitudinally in reference to the gill arch, the filaments appear honeycombed by countless perforations which measure about 0.1 by 0.05 mm. in major dimensions (Figs. 2 and 4). These oblong perforations are aligned in single files perpendicular to the gill arch. They are separated from one another by very thin membranes, which consist of a capillary[2] which is invested on two sides by a single layer of low cuboidal epithelium. These thin membranes obviously represent the lamellae (leaflets) or secondary folds of the gill filaments. Normally these minute lamellae extend outward and somewhat distally to their free tips from either side of the central supporting bar of each filament, which appear in

[1] Contribution from the Department of Anatomy, New York University College of Dentistry, New York City. Paper read at the 1934 meeting of the Society.

[2] According to the strict morphological definition, these vessels are not true capillaries, but functionally they may be so considered for all practical purposes.

longitudinal section much like the needles arising from a twig of spruce (such a section, of the pickerel *Esox,* is shown as Fig. 3). In *Amia,* the opposed tips of the lamellae which arise from adjacent filaments have become fused along a supplementary bar of supporting tissue,[3] which like each central primary bar extends at right angles to the gill arch. In this manner the spaces between the respiratory lamellae have lost their free communication with the branchial cavity along the distal ends of the lamellae. These spaces are the rectangular perforations which honeycomb each hemibranch as described above.

The mechanical advantages of this gill structure over the normal structure as exemplified by *Esox,* is seemingly a double one: (1) all the water in passing through the gills is forced into contact with the lamellar membranes, for none of the current is allowed to flow freely through or between the entire filaments: (2) the filaments and the lamellae are always held apart, preventing the collapse of continguous filaments on either side, and also of adjacent lamellae, and accordingly does not retard the free passage of water.

It is possible that this modified gill structure in *Amia* is utilized in atmospheric respiration. The rigidly separated lamellae would probably function admirably in air breathing due to the fact that the lamellae do not collapse, for as Carter and Beadle (1931: 360) point out, collapse of these structures is undoubtedly the most important factor in the death of fishes which have been taken out of their element. The compartment-like perforations would tend, by means of capillary attraction, to retain water in the filaments; this would keep the epithelial membranes which invest the lamellar capillaries moist, and thus lessen the chance for coagulation of blood in the gills and increase the tendency for substances such as oxygen, carbon-dioxide, and various electrolytes to pass through the lamellar epithelium. Furthermore, the movement of the gill arches and the filaments may have an aspirating effect, pumping air (or water) into the compartments.

The bowfin, however, remains in the water even though it thickens up into virtual mud (Dence, 1933; Gowanlock, 1933: 35). Although *Amia* apparently has not attained the stage of wandering about over the land, it does gulp air freely (Wilder, 1878; Reighard, 1903). While this engulfed air probably passes directly through the esophagus into the respiratory air bladder, it is possible that some of the air is stored and used for respiration in the branchial chamber. Whether the modified gills of *Amia* are adapted to and used for aerial respiration needs experimental determination.

This modification of gill structure in *Amia* seems to be unique among freshwater fishes. No published description of such a gill structure in any fish can be found, except for the sailfishes (Istiophoridae) and the swordfish (Xiphiidae). These marine fishes live in water rich in oxygen, but their tremendous size and activity call for an unusually large amount of oxygen, and hence for a very efficient gill apparatus. Dr. Hubbs finds that even in large young of *Istiophorus* the primitively separate arrange-

[3] A preliminary examination of the gills of some very young specimens of *Amia* seems to indicate that complete fusion of the lamellae occurs rather late in the life of the individual. A study of this process is now in progress.

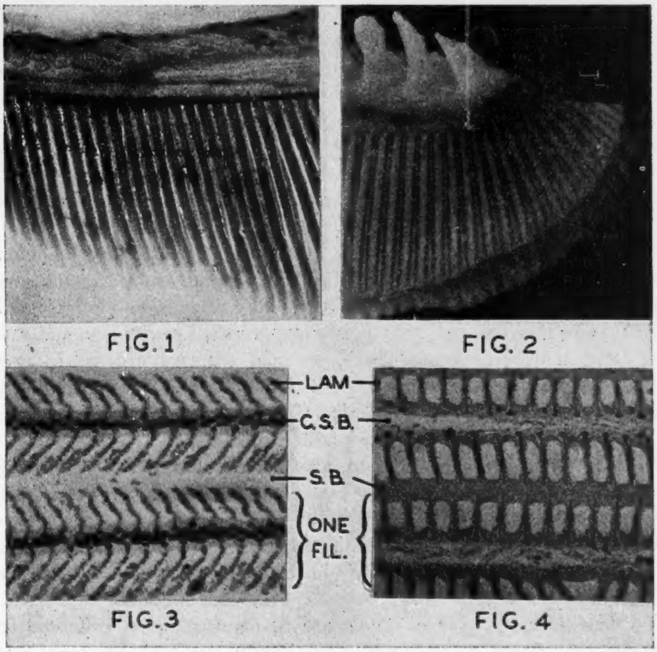

Fig. 1. A side view of a portion of intact gill arch of *Esox,* and filaments attached to the arch. Magnification 6.5×.

Fig. 2. A similar view of intact gill arch and filaments of a portion of the gill of *Amia.* Note that even at this low magnification the unusual structure of this gill can be seen. Magnification 6.5×.

Fig. 3. A section through two gill filaments of the pickerel, *Esox,* which are cut longitudinally in reference to the gill arch. Note that neither the filaments nor the lamellae are attached to adjacent filaments or lamellae respectively. Magnification 65×.

Fig. 4. A section, similar to that described for Fig. 3, of adjacent filaments of *Amia.* An additional structure, a supplementary supporting bar, occurs in this filament which makes possible the sieve plate arrangement of the lamellae. Magnification 65×.

Legend for Figures 3 and 4: C. S. B., central supporting bar; FIL., filament; LAM., lamella; S. B., space between filaments in *Esox,* and supplementary bar in *Amia.*

ment of the filaments persists, as also in the young of *Amia.* In a careful study of the gills in widely divergent groups of fishes, no similar structure has been encountered. It seems probable that the modified gills of *Amia* are related to its ability, vouched for by general reputation, of living in solid mud. There are not infrequent reports of dogfish being plowed alive out of muddy ground, in Louisiana (Gowanlock, 1933: 379) and through the Mississippi Valley (J. Clark Salyer,—personal communication).

Carter and Beadle (1931: 360), in their summary of the various struc-

tural modifications associated with fish life in stagnant water, state that only two genera, so far as they are aware, have modified their gills for such existence. These two fish genera are the eel-like *Hypopomus* and *Symbranchus*. In both, the modification is said to consist of an exceptional development of the "secondary folds" of the "gill lamellae" (the lamellae of the gill filaments according to the nomenclature which I have adopted in this paper). The modification of the gill structure in *Amia* is therefore much more pronounced than in the two South American genera mentioned above.

Another type of gill modification associated with an oxygen-deficient habitat is the development of external gills in the immature stage of several groups of fishes (for references see Dean's Bibliography of Fishes, 3: 585). These may be true external gills as in *Protopterus, Lepidosiren,* and *Polypterus* (and in urodele amphibians), or false external gills as in several teleosts (*Heterotus, Gymnarchus* and *Misgurnus*). The adults of all of these genera practice atmospheric respiration, *Misgurnus* in the intestine, the others by means of the air bladder.

Foetal sharks, as is well known, also develop temporary external gills which are supposedly used both for respiration and nutrition. Other viviparous fishes develop analogous outgrowths for the same purpose. Especially noteworthy are the fin flaps of embiotocid embryos (Ryder, 1893), and the complicated rectal processes of the cyprinodont fishes of the family Goodeidae (Turner, 1933: 207).

To conclude: the gills of *Amia* are in many respects different from those of other fishes. The lamellae are highly modified into sieve plates, which are presumably highly efficient in absorbing oxygen under low tension, and possibly serve also in atmospheric respiration. It is suggested that this specialization is correlated with continued existence and activity in stagnant marsh waters. This would help explain not only the habitat selection displayed by *Amia,* but also the survival of this "living fossil" into present times.

I am very much indebted to Dr. Carl L. Hubbs, for his helpful suggestions and criticisms in the preparation of this paper and to the New York Aquarium for specimens.

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Notes on the Sea Trouts of Labrador[1]

By Alfred C. Weed

ALONG the eastern coast of Labrador there are found three species or groups of species of the salmonid group commonly known as charrs. All three regularly or occasionally enter salt water. The lake trout, *Christivomer namaycush* (Walbaum), 1792, is a permanent resident of many of the lakes and is occasionally caught in the sea. The brook trout, a close relative of *Salvelinus fontinalis* (Mitchell), 1815, is found in practically all the streams and most of the ponds except those high up in the mountains. It regularly goes into the sea in summer. The sea-trout, a close relative of *Salvelinus alpinus* (Linnaeus), 1758, is found in practically all of the lower streams and ponds at some seasons, but spends a large portion of the year in the sea. It would be very interesting and important to find out whether any, or how many, of the brook trout and sea-trout spend the winter in salt water. For various reasons, I shall not attempt now to make a decision in regard to the proper specific name or names for the brook trout or for the sea-trout, or to the number of species in either of these groups north of the Straits of Belle Isle.

Lake Trout

The lake trout does not seem to be very well known to the Eskimo or white inhabitants of eastern Labrador. The Naskapi Indians know it well under the name "Kokomish" and fish regularly for it at certain seasons. They report that it grows to a length of about four feet.

Lake Trout and "Freshwater Cod."—The lake trout seems to be mixed up with some real or mythical creature known to the Eskimo and white

[1] Results of the Rawson–MacMillan–Field Museum Expeditions to Labrador and Greenland. Published by permission of Field Museum of Natural History.

inhabitants of Laborador as "iqluq" or "freshwater cod." Some say they are the same thing, others that they are entirely different. The matter is complicated by the fact that some of the Eskimos use the name "iqluq" for the sea-trout.

Tall tales are told of the size attained by the "iqluq" in certain lakes. The Eskimos report that it grows so large that they do not dare to put their kayaks in some of the lakes. It is possible that some of the stories may refer to a landlocked sturgeon, although definite records of sturgeon from middle and northern Labrador are lacking. The largest lake trout record we have from Labrador is of an example a little more than three feet long. Various Eskimos stated that the largest "iqluq" they had seen were: as long as a kayak; six feet long; three feet long; sixteen inches long. Walter Bromfield, who has been fishing around Jack Lane's Bay for many years, says that he has caught many "freshwater cod" in a pool in Hunt's River, just below the lower falls, about eight miles from the sea. He says they grow to a length of three or four feet and that they have a barbel on the chin just like a codfish. They have forked tails like a lake trout. Willie Mitsuq, who caught a specimen of lake trout for us in Adlutuk Bay, near Hopedale, called it "iqluq" and said that he had never seen one with a barbel on its chin. In spite of the statement of Walter Bromfield, the evidence at present seems to be that "iqluq" and "freshwater cod" are the same fish and that both are the lake trout.

The only definite records we have of lake trout from the eastern part of Labrador are from Adlutuk Bay, near Hopedale; from Upaqtik Bay, between Hopedale and Nain, and from a lake in the interior somewhere to the westward of Davis Inlet. It is quite possible that this fish may attain a weight of a hundred pounds or more in some of the Labrador lakes. A fish of that size might well be the basis of any of the big stories we heard.

Brook Trout

The brook trout of Labrador is called "anakleq" by the Eskimos. It is closely related to our eastern brook trout, *Salvelinus fontinalis,* but differs in several more or less important details. It is found along the whole east coast, at least as far north as the Nain region, both at tide level and well up in the mountain streams and ponds. E. P. Wheeler reported that in his surveying of the Nain region he found brook trout in a lake about 1500 feet above sea level and only a short distance, perhaps a mile or two, from salt water. Around the head of Anatalak Bay we found this fish as high as 1000 feet above sea level in some streams and absent at lower altitudes in other streams that seemed quite as suitable.

Topography.—The Rawson—MacMillan—Field Station was built on the shore of a small cove about three miles from the head of Anatalak Bay and about twenty-five miles from Nain. A large part of the cove in front of the house is a tidal flat that is covered with water at just a little below half tide. At the higher spring tides the salt water extends about a quarter of a mile up the cove from the house. A fairly large brook that I may call

the Station Brook enters the head of the cove and another about half as large drops over the escarpment in a series of cascades two or three hundred feet high, to enter the cove directly in front of the house. A few hundred feet of pipe brought water from this fall right into the house. We called this stream the Water Brook. The Station Brook has a series of cascades and three vertical falls giving a total drop of perhaps a hundred feet about a mile above the Station building. Above these falls the stream meanders through a series of mountain meadows, separated by rapids and low cascades, for several miles. Above the lower falls the Water Brook also meanders through mountain meadows separated by some steep rapids and cascades. The two valleys are separated at the head of the cove by a small mountain that we called Mt. Henderson. For a distance of two or three miles the south side of the Water Brook valley rises in a nearly vertical cliff about five hundred feet high. Just west of Mt. Henderson the valley broadens out in a mountain meadow about a mile long and nearly half as wide, with high cliffs on all sides except part of the north where there is a small glacial moraine holding back a pond about thirty feet above the general floor of the valley and about thirty feet below another smaller pond that is almost on top of the divide between this stream and the Station Brook. The distance from the larger pond to the Station Brook is perhaps a quarter of a mile. For purposes of reference we might call this larger pond Stickleback Pond. The head of the central stream of the Water Brook is perhaps a mile west of the head of the large mountain meadow. Streams falling over the cliff at the south side of the valley carry the headwaters back to the west two or three miles farther and several hundred feet higher than the Station Brook, although not more than a mile to the south of that stream. The Station Brook is well populated with brook trout as far as we followed it but the Water Brook has no trout in it above the foot of the lower falls. Much of the Water Brook seems as well adapted to produce brook trout as the Station Brook and I am a little sorry that I did not carry a few across the divide to Stickleback Pond.

Recent Glacial History.—The recent glacial history of the region seems to furnish the reason for the difference in the fish fauna of the two brooks. The Water Brook rises on the high land just south of the deep valley through which the Station Brook flows. The two run parallel and close together until opposite the Station, where the Water Brook turns sharply and falls over the cliff. Its former direct course seems to be blocked by glacial drift.

The evidence is very plain that in quite recent times the Water Brook valley was occupied by a glacier more than five hundred feet in thickness. A small remnant of the glacier still remains on the side of a mountain about five miles from the station and is plainly visible from Anatalak Bay. Most of the water from the melting of this ice and from another or a branch of the same glacier a little farther to the south flowed off to the southeast through a short channel to the bay. This must have been a very beautiful fall, dropping some seven to eight hundred feet in a very steep cascade. At the brink of the fall the stream was about a hundred feet wide and

some fifteen to twenty feet deep in the middle. This stream bed has been occupied so recently that it is not yet completely covered by grasses and lichens. The piles of trash that collected behind the boulders are still plainly visible. Water from the north side of the glacier, in very much less volume, filled the little basin of Stickleback Pond to a depth about fifty feet more than at present and spilled over the divide into the Station Brook.

Apparently few or no fish were able to climb the stream from the Station Brook to Stickleback Pond and none were able to ascend the Water Brook Falls after the glacier left that valley. There is abundant fish food in the Water Brook but no signs of fish to eat it with the exception of sticklebacks that have come down from Stickleback Pond.

Brook Trout in the Sea.—Brook trout weighing up to about two pounds are found in the sea from the time the ice first opens up early in June until late in the summer. Apparently many of those in the lower part of the streams go down to the edge of salt water on the tidal flats during their first or second summer. Probably all of them go back into fresh water about the time the ice begins to form. Many brook trout seem to be permanently resident in the streams, even though they have access to the sea, at least for the first few years of their life.

Food.—Brook trout in the bays of Labrador seem to feed almost exclusively on small crustaceans. Some that we caught had their stomachs crammed with beach fleas (*Gammarus*). Others had been feeding on the tiny swimming larvae of the "rock crab." The "rock crabs" are exceedingly common along the Labrador coast. Fish left in a net only a few hours will be almost completely destroyed. The females carry their eggs through the winter. The eggs begin to hatch about the first of May, while the bay ice is still sound. By the time the ice has gone the water is full of the larvae. In Anatalak Bay in 1928 they seemed to be evenly distributed about an inch apart through the entire bay from surface to bottom. They made it practically impossible to use plankton townets. All through the summer we found the stomachs of the brook trout filled with felt-like masses of these tiny creatures. We found few or no fish in these stomachs.

Color.—The brook trout seen at Anatalak Bay have three very distinct types of coloration. In the sea the trout is almost as silvery as a herring, with a brilliant metallic green back. The red spots are very faint, almost invisible, and the blue ring around them shows simply as a zone of different appearance. The vermiculate markings on back and fins are also very faint. The lower fins are colorless.

In fresh water the vermiculate markings are very evident. The red spots are highly colored, with the blue border very distinct. Most of the fish seen have the lighter parts of the back and upper side some shade of yellow, with the vermiculate streaks brownish. The lower side is more or less suffused with vermillion, which color also covers a large area on the lower fins. The regulation black and white edging on the lower fins is very brilliant. Under certain conditions the fish becomes almost black

on the back, the vermiculate markings obscured by the intensity of the color, while the red spots show like sparks of fire, with their blue borders sometimes very distinct and sometimes hardly visible. The lower sides glow with a deep red, which is also on the lower fins, while the white borders on the lower fins stand out like exclamation points against their black backgrounds.

It is hard to guess what causes the fish in fresh water to show the light or the dark color. Much of the bottom over which we find these fish is a light colored sand or gravel but there are patches of black mud or trash and some places where the water is red and the bottom covered with a red scum. In the fall of 1927 Mr. Rueckert was trying to make a drawing of the light phase. At that season the light color seemed less common and so more desirable. He found that his fish would turn dark very quickly on his table but that it would turn pale again if we set it on deck until ice crystals began to form in the water. His day was a constant succession of pilgrimages from his table to the deck and back again. Late in the next summer he tried to get a dark fish so that he might record its colors. We could not find any and could not persuade any of those we got to turn dark. Finally I found one in a shallow pool where the water was very red and the bottom covered with red slime. It was not so well colored as those we had seen the previous year but had to stand as an approach to the brilliant color those fish can show at times.

Sea-Trout

The sea-trout is known to the Eskimos as "eqaluk" or, sometimes, "iqluq." It is found along the entire eastern coast of Labrador, its range extending as far northward as there are open streams (probably as more than one species) and including the west coast of Greenland. It is closely related to the European charr, *Salvelinus alpinus*, etc., and differs from the brook trout in having a smaller mouth, a spotted instead of vermiculate pattern on the back, dorsal and caudal fins plain or only faintly spotted, red spots on the sides irregular in outline and not surrounded by a blue border, etc. The size of the mouth is extremely variable. Some specimens, males and females, have the mouth scarcely larger than that of a whitefish (*Coregonus*), while others have a very large mouth with strongly hooked jaws. Even in the ones with the largest mouths the maxillary bone does not extend nearly so far back on the side of the head as it does in the brook trout.

Size.—Adult sea-trout vary in size from a pound or two to ten pounds or more. Those with noticeably small mouths, as we saw them on the Labrador coast, rarely weighed more than a pound or two while those with large mouths reached a weight of eight to ten pounds. Large-mouthed specimens of a weight and size similar to the small-mouthed ones made up about half of those we saw at the head of Anatalak Bay. Spawning specimens that some Eskimo boys were catching about five miles up a small brook from Anatalak Bay, would, apparently, weigh close to five pounds, as an average, in extremely poor condition.

Migration to Salt Water.—Brook trout up to ten inches or more in length might be found in the lower courses of the streams at all times of the summer during our stay in Labrador but the only sea-trout we saw in the streams were breeding individuals or young that were plainly in their first year. Many young specimens, not more than three or four inches long were seen in shallow water in the bays, sometimes several miles from the nearest stream where these fish are known to breed or where we saw young sea-trout. In August, 1928, many sea-trout left the waters of the bay and started up the streams. They would congregate in the pools, below falls that would hardly cause a brook trout to hesitate, waiting for a rain to raise the waters so that they could go on. Many times we saw where they had been stopped by falls with a vertical drop of not more than a foot. They seem to keep going upstream until they reach a place where the vertical fall is too great to be wiped out by the rush of water from a heavy rain.

Spawning.—The one spawning bed that we visited was about five miles from the sea in one of the largest brooks flowing into the upper part of Anatalak Bay. The stream was narrowed abruptly to a width of about six feet between two rock ledges and then fell about six feet, at the time we were there, into a very deep, narrow pool. About a hundred feet farther down it spread out to a width of perhaps thirty feet with a depth of something like two feet in the middle. The current was so swift that a man could hardly stand against it in places where the water was not more than a foot deep. There were some boulders in the stream but much of the bottom was of rounded stones just too large to be carried along by the water. The fish lay, apparently motionless, in the swift water over these beds of stones and would return to the same places almost immediately after being frightened away. It must have required a tremendous effort for a fish to maintain its position in the swift current.

There is much to be learned about the spawning time and habits of the sea-trout. The spawning place mentioned above was visited October 18, 1927. The fish taken there were just about spent. The boys told us they had been on those beds two or three weeks or more.

The fishermen along the Labrador coast believe that some of the sea-trout spawn in the sea in summer. We have some evidence that suggests such a condition. The ice opened up so that I was able to set nets in the sea the last day of May, 1928. June 13 and 14, with the ice still in the bay, I caught sea-trout in salt water with free eggs in the oviducts. June 15, all the females I caught in the same place seemed very far from the spawning season. June 16, the ice all went out of the bay and we did not see any more, except big pieces grounded along shore. July 13, I caught two females with ripe eggs in the oviducts. On that date some of the members of the party found a pool in a brook at the head of the bay full of sea-trout waiting for a chance to go upstream. July 16, I caught a sea-trout with ovaries very large, apparently nearly ripe. July 18 there was only a single trout in the pool mentioned above. It was a male with very well developed testes. A rain had raised the water so that the other fish had been able to go up the stream but this one fish had reached that place just a little too

late. August 14 and 15, 1928, all the sea-trout I caught seemed to be very far from the breeding season. The ovaries were very small and the testes could hardly be detected.

We were very much confused by the conflicting evidence given above. Most or all of the sea-trout that were taken with ripe eggs in the oviducts were taken at times when the water in the brooks was very low and the fish could not have gone up stream more than a few hundred yards, at most, from the sea. None of them were taken very near any stream in which these fish are known or supposed to breed. The most we can say at present is that some sea-trout spawn in the brooks late in the fall, that others are, apparently, in spawning condition far from the known beds and as much as five months before the known spawning time, and that some fish are evidently very far from the spawning season at a time when others, with enlarged gonads, are hurrying to the breeding places.

Color.—The sea-trout, while in salt water, is almost as silvery as a herring. The back is metallic blue, the sides and belly brilliant silvery, the fins colorless. The red spots on the upper sides are indicated by very faint pink tinges. When they go into fresh water, the color of the back changes to a sort of neutral greenish brown. The red spots become more intense and the lower portion of the sides becomes suffused with red, scarlet in the females and vermillion or orange vermillion in the males. The red spots are larger than in the brook trout and are more or less irregular in shape, without a blue border. The lower fins become suffused with red and the black and white edgings become prominent. The spawned-out males we saw were very much compressed and deep-bodied while the females were very slender. This, with the much brighter color of the females, led us into an amusing error that was not corrected until we found that all our supposed males were laying eggs while milt was flowing from the "females."

Food.—Adult sea-trout probably do not eat much while in fresh water. In the sea they seem to eat mostly fish, but may take some of the larger crustaceans. I watched one hunting small sticklebacks in a small cove one day. The water was about six inches deep and the sticklebacks were working around a big boulder, with occasional excursions out into the open water. The trout, about six inches long, was working over the ground like a bird dog, picking up single fish. I saw it catch three or four within a very few minutes. On other occasions we would see a whole school sweeping along investigating everything on a front extending from the immediate edge of the water to farther out than we could see the fish. Those closest to shore would often be stranded by tiny waves.

FIELD MUSEUM OF NATURAL HISTORY, CHICAGO, ILLINOIS.

Geographical Variation in the Number of Rows of Pharyngeal Teeth in Cyprinid Genera

By V. D. Vladykov

THE large family of Cyprinidae, possessing approximately 200 genera is distributed in all parts of the world excepting South America, Australia and Madagascar. Thus representatives of this family are are found existing under different climatic conditions and therefore are interesting subjects for further study.

In this paper our attention is directed to the pharyngeal teeth only. Several cyprinid genera differ principally in the numbers of rows of pharyngeal teeth. In the literature, as far as we know, no detailed consideration has been given to the relation between the number of rows of pharyngeal teeth and the geographical regions inhabited. However, a comparison of the number of rows of pharyngeal teeth in the Cyprinidae and Catostomidae has been briefly treated: Segemehl (1891), Boulenger (1904) and Berg (1912) state that Catostomidae, possessing numerous pharyngeal teeth in a single row, are a more primitive group than Cyprinidae, having among other characters more specialized pharyngeal teeth in one or several (2 or 3) rows.

On the other hand, Regan (1908) considers the Cyprinidae as a more primitive group. Jordan and Everman (1896: 200) reconcile these two views thus: "the Old World Cyprinidae are at once more primitive and more highly organized than American forms."

In this connection, Berg (1912: 19) remarks: "that in America no Cyprinid genera exist with three rows of pharyngeal teeth, whereas in Asia genera with three rows are dominant. This circumstance seems to point to the fact that the American Cyprinids are more ancient."

Even among recent publications of several authors (Nichols, 1925 and 1928; Myers, 1926; Tchang, 1930 and 1931) dealing with Cyprinidae we do not find any mention of the problem in question.

The study of cyprinid genera from North America, Europe, East Asia (China), India and Africa shows quite clearly that the number of rows of pharyngeal teeth vary according to the geographical regions. Table 1 illustrates this relation.

Genera with three rows of pharyngeal teeth do not exist in North America. The number of American genera with one row are somewhat more numerous than those with two rows.[1] Passing to Europe we find about 9% of the genera with three rows of pharyngeal teeth, while genera with two rows of teeth are more common.

In East Asia (China) the genera with three rows are dominant (49%), approximately equalling the combined number of genera with one and with two rows of teeth. In India (Burma and Ceylon), the number of genera with three rows is higher than in China, approaching 70%.

In Africa we can expect the same relationship as was pointed out for

[1] Genera with species possessing a variable number of rows of pharyngeal teeth (1-2, or 2-3) are not included in our calculations since they occur only in very small numbers.

India and China. However, a calculation of genera (see Table) shows that the number with two and three rows is equal (37.5%). This apparent contradiction can be easily explained by the fact that there occur in Africa, according to Boulenger (1909), only 8 genera, only one-third the number reported in India, for example. If we compare the relations, not between genera but between species, we find that the number of African cyprinids possessing three rows of pharyngeal teeth is extremely high, 235 or 90%, whereas only two species (0.6%) have one row.

TABLE 1. RELATIVE PERCENTAGE OF CYPRINID GENERA POSSESSING DIFFERENT NUMBERS OF ROWS OF PHARYNGEAL TEETH[2]

Regions:	No. of rows of pharyngeal teeth			Total no. of genera
	1	2	3	
North America	46.0	40.5	—	37
Europe	41.0	50.0	9.0	22
East Asia	23.0	23.0	49.0	57
India	8.0	12.0	68.0	25
Africa	12.5	37.5	37.5	8
Africa	0.6	3.0	90.0	262 species

It is evident that the number of cyprinid genera with three rows of pharyngeal teeth increases from north to south, or rather from northwest to southeast. The genera with one row of teeth are dominant in Europe, where their number decreases in a direction towards the northwest as well as the southeast.

It should be noted that we do not consider the figures given above as absolutely definite, because they are taken from various authors who indeed may have drawn the limits of genera on a somewhat different basis. However, all the facts suggest the idea that the differences between cyprinid genera from various regions in respect to the number of rows of pharyngeal teeth is correlated with the peculiarities of the region inhabited by these fishes. Probably the differences in the environmental conditions[3] through a long geological period, as well as during recent time, are responsible for these differences in the number of rows of pharyngeal teeth.

It is interesting to note that even the earliest cyprinid fossils, from the Oligocene, belong to the same, or closely related, genera as recent cyprinids. In this connection Zittel (1902: 101) states that: "most of the known fossil species, all from fresh-water formations, belong to the existing genera *Leuciscus* Klein, *Tinca, Gobio, Barbus* Cuv., *Rhodeus, Aspius* Ag., *Cyprinus, Cobitis* Linn., *Nemachilus* Cuv., *Thynnichthys* Bleeker, etc. The only extinct genera such as *Amyzon, Diastichus, Oligobelus* Cope, and others, are closely related to existing forms."

From the above it is quite evident that among the fossil cyprinid forms, practically the same differences are found as among living genera.

2 Information concerning the cyprinids of North America is taken from Jordan and Evermann (1896); those of Europe principally from Berg (1912 and 1923), Karaman (1924) and Vladykov (1931); of Asia from Berg (1923), and Tchang (1930); of India from Day (1878), and Africa from Boulenger (1909-11).

3 The term "environment" is used in its broader sense, corresponding to the meaning of *geographical landscape* of Berg (1926: 264), which he defines as "a region in which the character of the relief, climate, vegetation, and soils are united in one harmonious whole, which is typical of a certain zone of the earth, recurring throughout its entire area."

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Herpetological Notes

THE RELATION OF THE FEMALE FOUR-TOED SALAMANDER TO HER NEST.—The female of the salamander *Hemidactylium scutatum* is generally supposed to remain with her eggs until they hatch, but observations show that this is not strictly true, at least in southern Michigan.

At the beginning of the egg-laying season from one to several females may be found in one nest. A typical situation is illustrated by observations of April 14, 1931, when fourteen nests showed a variation in attendant females from one to fourteen. The data summarize as follows:

NUMBER OF FEMALES OF *Hemidactylium* IN ONE NEST ON APRIL 14, 1931

Number of females in one nest	Number of eggs in nest	Number of females in one nest	Number of eggs in nest
1	None	2	About one complement
1	None	4	Few eggs
1	None	6	Few eggs
1	Few eggs	11	About 3 or 4 clusters
1	Few eggs	12	Few eggs
1	Few eggs	13	About 3 or 4 clusters
1	26 eggs	14	About 3 or 4 clusters

Later in the season there is usually only one female to a nest even though the eggs be very numerous, the product of several females; thus data similar to the above obtained in the month of May offer a decided contrast.

NUMBER OF FEMALES ON ONE NEST ON VARIOUS DATES IN MAY

Date	Number of females on nest	Number of eggs	Date	Number of females on nest	Number of eggs
May 6, 1933	3	644	May 20, 1923	0	31
May 12, 1933	2	1110	May 20, 1923	1	33
May 13, 1922	1	22	May 20, 1923	1	35
May 13, 1922	1	53	May 20, 1923	0	46
May 13, 1922	1	71	May 20, 1923	0	120
May 13, 1923	2	77	May 25, 1923	1	65
May 14, 1922	0	173	May 25, 1923	1	70
May 14, 1922	1	35	May 1926	1	24
May 20, 1923	0	30	May 1926	1	62

When the number of eggs is less than 40 they probably represent a single clutch, and the accompanying female is presumably their parent. But some single sets have no attendant female and nests that obviously comprise two or more complements have usually fewer than the corresponding number of females. The above figures for May are duplicated exactly by many observations in the last part of April. Nests of 435 and 487 eggs had only two attendant females each, and only one female was present with each of the following nests: 247, 250, 267 and 320 eggs.

It is clear that there is a strong tendency for the female *Hemidactylium* to remain with her eggs. In one instance this instinct to seek a nesting site and remain there persisted long after there was any need of it. A fully grown female was found on May 20 (1922), about a month after the beginning of the egg-laying season, in a good nesting site but with no eggs. Dissection of the specimen showed five deteriorating eggs in each ovary. The body cavity had in it a lot of material that under the microscope certainly appeared to be yolk granules. The oviducts were rather swollen and in the anterior end of the left one was some material that proved under the microscope to be yolk granules. Something had prevented the laying of the eggs, but the female was still under the impulse to wait for them.

Why do the excess females leave the nest? If there is some antagonism between individuals it does not develop until after the eggs are laid, or females would not congregate so closely before laying. While some females are staying with their eggs

others, that dissection proves have laid eggs that season, have been collected in terrestrial situations.

We may summarize these remarks by saying that the female *Hemidactylium* usually stays with her eggs until they hatch unless her nest is closely associated with one or more other nests. In the latter event it is usual for all but one of the females to desert the nest. Only occasionally will even two remain. FRANK N. BLANCHARD, *Zoölogical Laboratory, University of Michigan, Ann Arbor, Michigan.*

GEORGIA RECORDS OF *GASTROPHRYNE CAROLINENSE* (HOLBROOK).—Wright (1931: Frogs of the Okefinokee Swamp, Georgia: 453) states that in traveling southward "Our course through Durham-Charlotte, N. C., Blacksburg-Anderson, S. C., Atlanta-La Grange, Ga., West Point-Tuskeegee, Ala., was too far inland to record this Lower Austral species . . . Strecker (1909, p. 120) restricts it 'principally to the humid division of the Lower Austral Life Zone'." This trip was made in 1917.

Wright further records *Gastrophryne carolinense* at Screven, Georgia (June 11, 1926), and in the Okefinokee region on numerous occasions. This species is represented in the United States National Museum by specimens from Muscogee, Chattahoochee, Glynn and Liberty counties. Certainly all of these localities may be considered as falling in the Lower Austral Zone of Georgia.

However, in 1931, George D. Walters, Jr., Bettina B. Carter, and I found four specimens of the narrow-mouthed toad in Fulton County, near Peachtree Creek at an elevation of about 800 feet. They were taken in a slightly moist situation, under logs. No others have been taken here, nor has careful search on the Coastal Drainage slopes in DeKalb County revealed this species. Since it is known from Muscogee and Chattahoochee counties, it is entirely possible that this species follows the valley of the Chattahoochee River in the Appalachicola Basin, but does not cross the Fall-line hills at other points.

Doubtless the progress of this herpetological survey will indicate more completely the distribution of Georgia reptiles and amphibians. The specimens listed above, as well as most of our other specimens are now in the Museum of Comparative Zoology.—H. A. CARTER, *Department of Game and Fish, Atlanta, Georgia.*

NOTES ON THE HABITS OF THE SHORT-TAILED SNAKE, *STILOSOMA EXTENUATUM* BROWN.—Since the short-tailed snake, *Stilosoma extenuatum,* has apparently been little observed, it may be worth while to record certain observations made on a captive specimen.

This specimen is an adult male, twelve inches in length, collected at Umatilla, Lake County, Florida, on January 25, 1934, and appeared to be unique in that it had a ground color of uniform bright scarlet. My excitement over an apparently new phase of a rare snake subsided with the information that the coloring was caused by cochineal cake dye. (The snake had been dropped into a jar containing a small amount of this substance.) Subsequent washings with warm water and soap failing to remove the dye, the snake was placed in a small glass aquarium to await shedding.

During the month that this specimen has been kept in captivity it has been handled frequently and has shown evidence of being far more intelligent and aggressive than any other of the small burrowing species that I have observed.

Although most of its time is spent under the sphagnum floor of the aquarium, the snake emerges frequently to explore with its tongue the sides and bottom of its cage, even pushing with its head against the glass lid of the aquarium. When a watchglass of water is proffered, it usually immerses its head and drinks for several minutes. When handled, although alert, it seems quite unafraid, and if treated roughly it becomes enraged, coiling, vibrating its meagre tail, and striking like an irate blacksnake.

Its powers of constriction and muscular control are remarkable. When it coils about my first and second fingers, I find it impossible to part them. In crawling from one of my hands to the other it bridges gaps slightly wider than half its length, and like the larger constricting snakes, it is capable of progressing several feet along a taut wire.

On February 25, 1934 (the date on which the *Stilosoma* finally rid itself of its scarlet skin and assumed a normal coloration) an adult crowned-snake, *Tantilla coronata* (Baird and Girard), eight inches long, was dropped into the aquarium. Two hours later, when I revisited the aquarium, the short-tailed snake had a jaw-hold about half an inch behind the head of the *Tantilla,* and had thrown three coils of its body about the latter's mid-section. The *Tantilla* was completely dead. The *Stilosoma* worked its jaws along the neck of the dead snake, and on reaching the head, began the swallowing process. Using the combined "walking" action of its jaws and the pushing action of the never-relinquished coils, the *Stilosoma* finally succeeded in ingesting its victim. The entire process took two hours and fifteen minutes.

When the tip of the *Tantilla* tail had disappeared, the *Stilosoma* elevated its head and contracted the muscles of the anterior region of is body violently. It gaped several times, scraped the sides of its jaws against the walls of the aquarium to force them into place, and dragged its stuffed and nearly rigid body under the sphagnum, to remain for several days.

The methods used by this diminutive serpent, and its feat of killing and consuming a snake two-thirds its own length and over half its girth, place *Stilosoma* on a par with the king snakes as a constrictor and an ophiophage.—A. F. CARR, JR., *Department of Biology, University of Florida, Gainesville, Florida.*

CONTRIBUTION TO THE HERPETOLOGY OF ARKANSAS.—We had heard about the coon-tailed rattlers in the mountains west of Little Rock, Arkansas for several years. The natives are careful to distinguish the difference between these coon-tails, *Crotalus atrox,* and the velvet-tails, *Crotalus horridus.* In questioning residents of Saline County we found that they consider the coon-tails as common in the high mountains of the whole region west and northwest of Little Rock, and one of the mountaineers who had hunted extensively told us they range throughout the mountains to the northwest of Little Rock for a distance of a hundred and fifty miles. He told us they were essentially snakes of the mountains, and denned in masses of rocks at the very top of the mountains. The velvet-tails, on the other hand, are snakes of the lowlands, and do not ascend the mountains farther than the low lying hills. In northeastern Arkansas, however, where the hills are not so high and the bottom land is more extensive, one of us has found the two species together in the low hills.

Our first day's hunt took us to Rattlesnake Mountain, where we went to investigate a snake den. Some of the mountaineers living nearby never go on this mountain for fear of the snakes. About the only time it is visited at all is in the fall when the men hunt, or when they are looking for an occasional stray cow or horse.

We reached the mountain about ten in the morning of April 18, 1932, and found the den as described at the very summit (about one thousand feet elevation). Two *C. atrox* were immediately located. They were lying among the rocks just at the entrance to a hole which led beneath a huge boulder. Before all the party could arrive the first observer noticed another snake lying a bit to one side in the direct rays of the sun. As there were three of us who could catch venomous snakes we each picked out one, and at a given signal the one above the snakes slipped a hooked stick under the two and tossed them clear of the hole. We each pinned a snake to the ground, and as luck was with us, caught all three.

Farther down the mountain another *C. atrox* was noticed, but before it could be pinned to the ground it slipped under a boulder. We poked sticks and twigs under the rock, and after a while saw there were two instead of one. Finally after much maneuvering both were forced to run out. One had been in the sun and was active, but the other had been in the shade of the rock and was cold and put up little fight. They seemed to be running in pairs this day.

Shortly after a pair was found on another mountain slope in the process of courtship. The male was the smaller of the two. He paid no attention to us when we disturbed them. The female was lifted clear of the male and taken about fifteen feet away. At her departure the male became very excited, and crawled rapidly in her direction. We moved her about several times, and each time the male would crawl towards her as fast as he could. Upon reaching her he would continue his amorous tactics. Our presence seemed to make little difference to him, for he would crawl

towards us, or even between our legs, without rattling or assuming an aggressive attitude. After being disturbed the female only tried to escape.

Of ten *C. atrox* caught on this and a succeeding day eight were found in pairs, one in association with a pair, and one singly. A pair of copperheads, *Agkistrodon mokasen*, was taken less than five hundred yards from the rattlesnake den, and nearby also a pair of coachwhips, *Coluber flagellum flagellum*, was seen, but only one was caught. This seems to indicate that we reached the mountains during the spring mating period. The other snakes caught in the lowlands where the vegetation was farther advanced were all found singly, and from this we suppose the mating period of the lowland snakes had already passed.

Of the seven days spent in the field on this trip two were in *C. atrox* territory. The remainder of the time was spent in the lowlands. Following is a list of the material collected: 10 *Crotalus atrox*, 4 *Crotalus horridus*, 6 *Agkistrodon mokasen*, 12 *Agkistrodon piscivorus*, 3 *Coluber flagellum flagellum*, 2 *Lampropeltis getulus holbrooki*, 1 *Lampropeltis calligaster*, 1 *Elaphe laeta*, 27 *Tantilla gracilis*, 8 *Elaphe obsoleta obsoleta*, 4 *Coluber constrictor constrictor*, 3 *Natrix rhombifera*, 5 *Natrix sipedon transversa*, 1 *Natrix grahamii*, 1 *Thamnophis sauritus*, 1 *Heterodon contortrix*, 1 *Storeria dekayi*, 1 *Ophisaurus ventralis*, 3 *Anolis carolinensis*, 2 *Hyla cinera cinerea*.

Although on this trip we did not have an opportunity to hunt in northeastern Arkansas we have both seen specimens of *C. atrox* from that region. Prior to 1927 one of us (Lentz) caught *C. atrox* in Clay County, Arkansas, and as late as 1932 saw two killed by a roadside not far from Piggott. They are to be found in the bottom lands of Cache and Black rivers during the summer time, and in the low lying hills nearby in the spring and fall. Lentz has formerly caught *C. atrox* across the Black River in the bottom lands of Butler County, Missouri, south of Poplar Bluff. Fifteen years ago they were considered common in this region, but now are very much thinned out.

SUMMARY.—*Crotalus atrox* is found in Arkansas in Saline County in the central part of the state, and in Clay County in the northeastern part of the state. If their range is continuous they may be expected in the mountainous counties northwest of Saline County, viz. Perry, Yell, Logan, Sebastian, Crawford, Franklin, and possibly Madison and Newton counties. Likewise may this species be expected to the northeast in Pulaski, White, Jackson, Independence, Lawrence, and Greene counties.

An overlapping of southwestern and southeastern species was noticed from finding *Crotalus atrox* (southwestern) and *Anolis carolinensis* (southeastern) side by side.

The scutellation of the Saline County *C. atrox* checks with Texas specimens, although in coloration they are slightly greenish, and the diamonds seem more round.—R. MARLIN PERKINS and MOODY J. R. LENTZ, *The St. Louis Zoological Garden, St. Louis, Missouri.*

NOTES ON NORTHWESTERN AMPHIBIANS.—On October 1-2, 1932, while on a field trip to Spirit Lake, at the base of Mount St. Helens, with Harold Johnson and Govner Teats as companions, I found many individuals of *Rhyacotriton olympicus* in and near the small streams which drain into Spirit Lake on the west side. These specimens averaged larger than those taken in streams in the Olympic Mountains under similar conditions. We also took *Ascaphus truei* and *Dicamptodon ensatus* in the same stream as the Olympic salamanders, on the west side of Spirit Lake. This record extends the known range of *R. olympicus* into the Cascade Mountains, and fifty-two miles east of the locality where it was last reported (Slater, COPEIA, 1933: 44).

The Spirit Lake region was visited to see the black salamanders reported to be in the pumice or tree wells around the lake. In some former age the volcano, now Mount St. Helens, threw out small pieces of pumice and other material and buried a heavy forest many feet above the base of the trees. These trees died, and now another forest stands at a higher level. The trees of the old forest have decayed and the volcanic material packed around the trunks has in some instances held its shape; the disappearance of the decayed wood has left "well" shaped holes in the earth. We observed *Ambystoma gracile* and *Bufo boreas* in these wells, but were unable to collect them as they would not take a fish hook, and we had no means of climbing down to them. In a recently dug hole we observed about twenty amphibians

of five species: *Ascaphus truei, Bufo boreas, Rana pretiosa, Ambystoma gracile* and *Triturus torosus.* They had developed tunnels at the base of this hole in the sand walls for eight or ten inches. The amphibians in the wells and hole seemed strong and healthy, so apparently enough small animals fall in to keep them well nourished.

When returning to our camp from one of these wells at about 11 P.M., we found specimens of *Ascaphus truei* on the forest floor a long distance from the lake and any pond or stream, and there had not been recent rains.

Svihla (COPEIA, 1933: 38) reports that he kept *Ascaphus* tadpoles alive in a fruit jar for two days with the temperature rising as high as 15°C. Putnam, in his unpublished thesis on *Ascaphus* in the State College Library at Pullman, Washington, also states that it is very difficult to keep the tadpoles alive; that he had to run from one stream to another in the Olympic Mountains to get fresh, cool water on the tadpoles at short intervals so he could get them to his outdoor laboratory near Lake Cushman alive. On June 19, 1930, after keeping live *Ascaphus* tadpoles in my laboratory for a few days, I took them to Eugene, Oregon, and back in my car for the meeting of the Society of Ichthyologists and Herpetologists. I did not use ice or other artificial means of cooling, and did not even change the water on the way.

While on a field trip in British Columbia with Gordon D. Alcorn on May 30, 1932, I found *Plethodon intermedius,* with other amphibians, at the Bridal Veil Falls near Pokum, B. C., which is thirty-two miles or more north of the last reported record, near Baker Lake, Washington (Svihla, COPEIA, 1933: 39)—JAMES R. SLATER, *College of Puget Sound, Tacoma, Washington.*

A NOTE ON THE RED-BACKED SALAMANDER AT ROCHESTER, NEW YORK.—The recent paper by Blanchard[1] on the red-backed salamander, *Plethodon cinereus,* in southern Michigan, provides the opportunity for a comparison between members of widely separated colonies of a single species.

In the lower gorge of the Genesee River at Rochester, New York, the red-backed salamander is extremely abundant. During the spring and fall of 1929 and 1930 nearly six hundred specimens were taken, of which about one-third were immature and the remainder about equally divided between the adults of both sexes.

Measurements of 157 adult males and 154 adult females show that the males not only average shorter than the females in body length, as indicated by Blanchard, but that the tail of the male is also shorter, the greater length of the female being mostly in the trunk. Only perfect specimens were considered and the body measurements were taken from the end of the snout to the posterior end of the vent. The measurements in mm. are indicated below:

Sex	Average total length	Average body length	Average tail length
Males	73.82	40.55	33.27
Females	77.83	43.28	34.54

When the measurements of this group of specimens and the immatures are plotted, they present a curve essentially similar to that given by Blanchard.

Contrary to the findings of Blanchard in Michigan, where the two color phases were found to be nearly equal in numbers, 95.7 per cent of those taken in the Genesee gorge were of the red-backed phase.

Among the salamanders collected October 7, 1929, were 55 adult males, every one of which was carrying a spermatophore. A part of the gelatinous base of the spermatophore protruded from the cloacal lips, while the sperm cap was within. In females taken at the same time and place there was no evidence of spermatophores, and sections through the spermathecae failed to reveal the presence of sperm. It is evident that the males, although carrying spermatophores ready for deposition, had not yet found mates. On October 16 an additional lot of specimens was collected, including 25 adult females. Five of the 25 females were found to be carrying spermatophores in the cloacal lips and a number of others, sectioned through the cloaca, revealed sperm in the spermathecae. None of the males collected on the later date was carrying a spermatophore.

Records of the Weather Bureau for the Rochester region were examined, covering a period of three weeks prior to October 2, and it was found that there had been 1.15 inches of rain. On October 2 there was a heavy downpour during which

[1] Amer. Nat., 62, 1928: 156–164.

2 inches of rain fell. This was followed October 6 and 7 by a marked rise in temperature which may perhaps be correlated with the activity of the males in producing spermatophores. During the period from October 7 to 16, when mating occurred, the weather was fair and the temperature normal for the season.—HELEN HINCHER HOOD, *University of Rochester, Rochester, New York.*

THE HIBERNATION HABITS OF THE RATTLESNAKE OF THE NEW JERSEY PINE BARRENS.—Due to a lack of rock the rattlesnake of the New Jersey Pine Barrens must modify its hibernation habits from denning in rocks to burrowing in the sand. This fact was brought to our attention during a camping trip at Mount Misery, New Jersey, by Asa Pittman, a dealer in local reptiles at Upton, New Jersey. The facts he supplied, we have checked by going over a site where he dug up rattlesnakes, as well as by independent conversations with people who helped him collect. We have also secured one specimen, *Crotalus horridus*.

The typical barrens are fairly level land covered with *Pinus rigida* and scrub hardwood, and floored with sand. In declivities of the land are "cedar" swamps whose banks are short sandy grades. In these banks the snakes winter, utilizing a spot well up on the bank where there is a spring. In the wet sand below the spring, even in water, they are found but not in the swamp itself. They burrow down in the sand to an average depth of two feet; the burrows being simply long enough to allow them to get to the desired depth. Presumably such wet situations are chosen because there is little danger of the spring water freezing as the winter of the Barrens is rather mild.

The exposure of a situation at Mount Misery is east, so there is no uniform southerly orientation. The number of animals found at this spot was over thirty. While denning in the restricted area below a spring, the rattlers were found in individual clusters of from three to ten animals per cluster. Other species were not found intermingled.

These snakes den about the end of October, the time varying of course with the temperature, and appear in spring around the middle of April. In the fall they return to the vicinity of the "camp" during September; the same area is used year after year. If the winter is warm, rattlesnakes may be found out of their burrows.

This type of hibernation rather nicely illustrates the modification of habits to fit existing conditions. While this summary is brief, we have no reason to doubt that the above-mentioned facts are correct. The specimens we have seen appeared to be identical with the Pennsylvania timber rattler, except for a rather uniform light coloration, although the number we have seen was not great.—J. WENDELL BURGER, *Princeton, New Jersey.*

MELANISTIC GARTER SNAKE RECORDED FROM VANCOUVER ISLAND.—Since Lozier (Trans. Roy. Canad. Instit., XVIII, pt. 2, 1932: 311–336) does not record melanism in *Thamnophis* of British Columbia, these Vancouver Island records are of interest. The first record is for Nanaimo, October 1, 1933, of a specimen very dark in color throughout, except for the somewhat paler posterior margins of the ventral scales, a fine light grey streak on the throat, and a few irregularly distributed small light grey spots on the anterior ventral scales. The second is for Departure Bay, April 15, 1932, of a specimen having a very dark back but a dark bluish grey cast to the under parts, the posterior edges of the ventral scales being rather lighter in shade than their general color. In this specimen there was a suggestion of red on the throat. In this specimen too, the sixth, twelfth to sixteenth, twenty-second to twenty-fourth, and the forty-eighth subcaudal scales were abnormal in not being divided. The following measurements and counts indicate that both specimens probably are melanos of the common *Thamnophis ordinoides ordinoides* (Baird and Girard).

			Dorsal scale rows:		
Length	420	412	1 cm. behind head	19	17
Tail	95	99	Thickest part of body	17	17
Preoculars	1–1	1–1	Immediately before vent	14	15
Postoculars	3–3	3–3	Immediately behind vent	9	11
Upper labials	7–7	7–7	Ventral scales	142	141
Lower labials	9–9	8–9	Subcaudals	59	63

JOHN LAWSON HART, *Pacific Biological Station, Nanaimo, British Columbia.*

Reviews and Comments

TROPICAL FISH AND THEIR CARE. By Norbert Lederer. Alfred A. Knopf, New York City, 1934: xxi + 229 pp. $2.50.—This is another of the several recently published manuals of tropical fish keeping in home aquaria. Part One, on general aquarium care, seems to be fairly good and plainly written. Unfortunately the same cannot be said for Part Two, covering the various species of tropical aquarium fishes. This section, which takes up the major part of the book, is composed of short general accounts of the various groups, padded with interminable lists of species, a considerable proportion of which are not now available on the American aquarium fish market. The descriptions of the individual species, largely confined to color, are mostly too short and too generalized to be of any value to either beginner or expert. On a hasty perusal we learn that gouramis die in the ecstasy of a kiss, that the Chinese bred the goldfish from the carp, that *Xiphophorus montezumae* is sometimes identified as a separate species, that *Heterandria formosa* inhabits the West Indies, that there are two known species of *Aphyosemion*, that *Betta splendens* disports itself in the Malay Archipelago, that *Herichthys cyanoguttatus* hails from the Amazon, that the piranha was first described in detail by Theodore Roosevelt, and that *Dermogenys* is a member of the Scombresocidae! On p. 79 a black spotted *Mollienisia latipinna* or *velifera* is labelled *M. sphenops* and opposite to it *M. latipinna* masquerades as *M. velifera*. Of most of the illustrations perhaps the less said the better.—GEORGE S. MYERS, *U. S. National Museum, Washington, D. C.*

THE AMPHIBIANS OF KANSAS. By Hobart M. Smith. Amer. Midland Naturalist, XV (4), July, 1934: pp. 377–528, pls. xii-xx, 24 maps.

"The present work has largely as its object the bridging of the gap in the knowledge of the amphibians of the central plains region. For this reason, it is largely taxonomic and distributional," but notes on ecology have been included. Each of the 25 forms admitted to the Kansas faunal list have been treated as to the known facts about their diagnosis, description, sexual dimorphism, life history, food, habitat and habits, distribution, and their history in the herpetological lore of the state. Four forms have been judiciously discarded from the Kansas list. The workable key to the adults of Kansas Amphibia should prove useful to students over a wide area, and the keys to the known larvae and eggs should be welcomed as well.

Mr. Smith is to be congratulated upon the organization of his work. The terse type of synonymy (adapted from Ruthven, Thompson and Gaige, The Herpetology of Michigan, 1928) could well be adopted by a wider circle at a saving of much printer's ink and with little loss of time to specialists. The maps show the general distribution of each form at a glance, but detailed locality records have not been omitted. The large bibliography, which includes 235 references, suggests the thoroughness with which the literature has been reviewed.

Upon a complete reading of the contribution a number of problems suggest themselves: (1) The relation of *Ambystoma tigrinum mavortium* to allied subspecies, (2) The determination of the validity of the proposed subspecies of *Triturus viridescens*, (3) The determination of the status of *Bufo fowleri* for "having cited similarities between *fowleri and woodhousii*, it is difficult to find differences that would justify even subspecific status," and (4) The working out of the relationship between *Pseudacris clarkii* and *P. triseriata*, which may be subspecies. Thus, as in the case of my own personal experience with the lizards, Kansas proves to be a starting point from which larger and more difficult problems in herpetology may be discerned. Ensuing studies carry our interest in all directions, but particularly to the east and west, away from this zoogeographical crossroad that exists today.—CHARLES E. BURT, *Southwestern College, Winfield, Kansas.*

Editorial Notes and News

News Items

ON September 15, 1934, the New Reptile House of the Toledo Zoological Society was officially dedicated and opened to the public. The plans were drawn up under the supervision of Roger Conant, and the erection was accomplished through the cooperation of the FERA and CWA with the Toledo Zoological Society. The building is carefully designed and provided with excellent facilities for the exhibition and safe handling of live reptiles and amphibians. The Toledo Zoological Society should be congratulated upon acquiring one of the best equipped reptile houses in the country.

W. C. T. Herre has returned to Stanford University from a long collecting trip in tropical waters. He reports very fine fish collecting at Wuchow, China, and in the Malay Peninsula.

The Borough of Staten Island, New York City, is constructing a Zoo and Tropical Fish Aquarium under Public Works funds, at a cost of more than $100,000. The Aquarium will have a laboratory and library, and should be an important factor in developing the tropical fish hobby.

Charles Walker, on leave from Ohio State Museum, is completing his work on the genus *Pseudacris* at the Museum of Zoology, University of Michigan, as a Hinsdale Fellow.

Percy S. Barnhart, of the Scripps Institution for Oceanographic Research, at La Jolla, California, has completed an illustrated manual of the Fishes of Southern California.

Notice has been received of the sudden death of the Canadian ornithologist and herpetologist, R. Owen Merriman.

Norman E. Hartweg has been appointed Assistant Curator in the Division of Herpetology of the Museum of Zoology, University of Michigan.

Dr. W. A. Clemens and G. V. Wilby have in preparation a treatise on the fishes of British Columbia.

Fisheries Research News

LAST summer, the faculty and students of the Department of Fisheries, University of Washington, Seattle, were variously occupied. Dr. W. F. Thompson, head of the department and Director of the Internation Fisheries Commission, remained in Seattle in charge of the halibut investigations. Dr. James E. Lynch continued his research work on fish parasites and the invertebrates of the region. Dr. Leonard P. Schultz spent the summer in Glacier National Park, studying the fish fauna and their natural history on the biological survey by the U. S. Bureau of Fisheries. Mr. L. R. Donaldson was at Jackson Hole, Wyoming, in charge of a new U. S. Bureau of Fisheries hatchery for the summer. Among the graduate students, Allan C. DeLacy, Mr. Kelshaw Bonham, and Mr. Arthur Welander took part in the U. S. Bureau of Fisheries biological survey in California. Mr. Fred Thompson was engaged in fish culture work in Yellowstone Park.

A new fisheries organization, the *National Planning Council of Commercial and Game Fish Commissioners* was formed in St. Louis on April 23, at a meeting called by the U. S. Commissioner of Fisheries. The purpose of the organization is to coordinate fisheries activities in the several states, and to develop cooperative relations with the U. S. Bureau of Fisheries.

Dr. Frederic F. Fish, associate pathologist of the U. S. Bureau of Fisheries, has conducted a cooperative investigation of fish diseases in the fish hatcheries of Oregon.

Henry O'Malley, former Commissioner of Fisheries from 1922 to 1933, retired from service in the Bureau of Fisheries on September 1. Mr. O'Malley's regime was marked by a material expansion of the federal fisheries activities, including the investigational lines.

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